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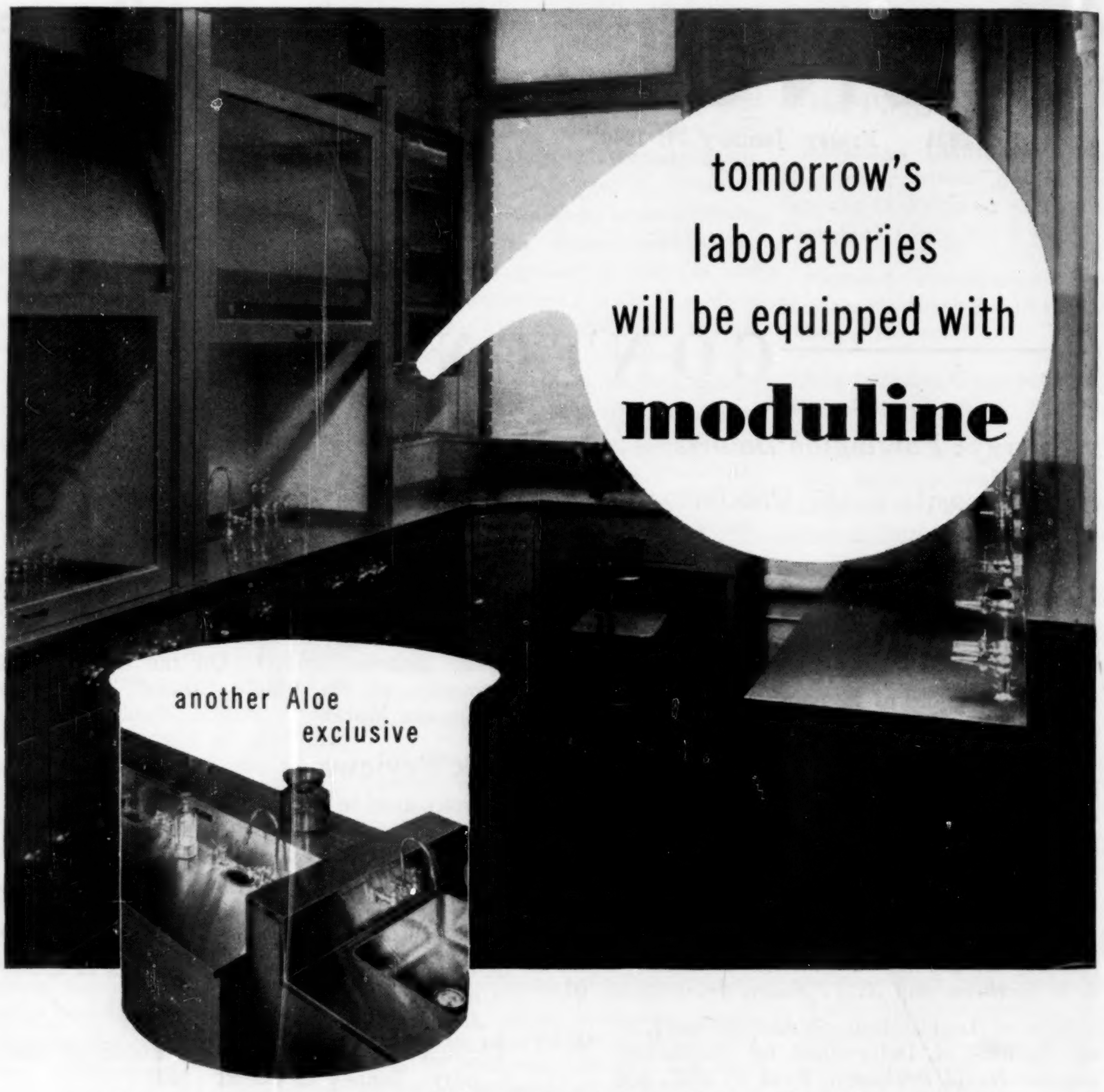


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# Solar Energy

Farrington Daniels, *University of Wisconsin*

FROM THE DAWN OF HISTORY man has realized the importance of the sun, but only in the present scientific age has he begun to appreciate the vastness of this source of energy and the extraordinarily clever mechanisms by which nature makes efficient use of it. In these times of profligate spending of the world's natural resources (*12*) and uncontrolled increase in population (*12, 18*) it is our task on this 100th anniversary of the founding of the American Association for the Advancement of Science to try to see what lies ahead. Science has pulled us out of many difficulties in the past—and has given us the means for getting ourselves into worse ones. When we have used up our coal and oil, exploited our available land with intensive farming, and trebled our population, can we then call on the sun to give us still more means to satisfy our ever increasing demands for food, fuel, and power? *The answer is yes.* But there is a long challenging road of research and development which must be followed first—and we must not get the idea that we are about to step into a new era of physical and economic abundance. We can't eat sunshine, we can't carry it where we want to use it, and, because it cannot easily be used to produce high temperatures, we find it is difficult to apply directly in our heat engines.

### Amount of Solar Energy

The earth intercepts a prodigious amount of radiant heat from the sun (*13*)—about $5 \times 10^{20}$ large calories or kilocalories per year, arriving at the surface of the earth. Five followed by 20 zeros is too large a figure to register with most of us, but suppose one considers the amount of energy in terms of an acre. An acre is roughly a square of land 200 feet on a side, a little less than the length of half a city block, with an area of about 40,000 square feet. In most parts of the United States the solar energy averages more than one kilocalorie per square foot per minute (*6*), or 500 kilocalories per day. Since each one of the 40,000 square feet in an acre receives 500 kilocalories each day, the whole acre receives 20,000,000 kilocalories per day. Let us see what these figures mean in terms of food, fuel, and power. In the continental United States there are now nearly 144,000,000 people and nearly 2,000,000,000 acres of land (*21*), giving an average of about 14 acres per person, and a theoretical average of 280,000,000 kilocalories of sunlight per day per person.

Each person uses about 3,000 kilocalories to maintain himself with food, and vastly more for heat and power. In 1946, 583,000,000 tons of coal (*22*) were used for, heat, light and power by 140 million people in 365 days—an average of 20 pounds person per day or 75,000 kilocalories; 1,700,000,000 barrels of oil were used for heat and power including automobiles —an average of 50,000 kilocalories per person per day; nearly 4,000,000,000,000 cubic feet of natural gas were used, an amount equivalent to 21,000 kilocalories per person per day. On the average then, each person had 3,000 kilocalories from food and 146,000 from coal, iron, and gas—a total of nearly 150,000 kilocalories per day. When this total is compared to his theoretical average of 280,000,000 kilocalories from the sun, we see that the sun supplies to the United States nearly 2,000 times as much heat energy as is now used. It must be emphasized that most of the heat energy now used comes not from the daily supply of solar energy but from the solar energy stored up in bygone ages.

### Utilization of Solar Energy

Of the sun's radiation which hits the earth's atmosphere a considerable portion is reflected and scattered, so that about 1 kilocalorie per minute on the average, in the Temperate Zone, reaches a square foot of land or water. Some of this is used in the evaporating of water which, however, releases this heat again when the water vapor condenses as rain or snow. Most of the visible sunlight, constituting about half of the total radiation reaching the earth, can be used for producing carbohydrates and other organic material if it strikes growing plants on land or in the sea, and the remainder is available for raising the temperature. The tendency for the earth's temperature to rise, due to solar radiation and by decay of radioactive elements in the earth, is nicely counterbalanced by the cooling caused by infrared radiation from the earth corresponding to the earth's temperature (*2*).

How can we convert this 20,000,000 kilocalories per acre per day into useful power? If it could be used to operate a modern steam engine or hot gas engine with a normal efficiency of 25 per cent, we could obtain electrical power equivalent to 240 kilowatts per acre. But this plan is not now practical because the sun's radiation falling on the earth's surface does not create high temperatures unless it is concentrated or special precautions are taken to reduce heat losses.

**"Solar Energy" was one of the addresses delivered at the Symposium on Sources of Energy, held in Washington, D. C., on September 15, during the Centennial Celebration of the AAAS.**

Just as we must have a difference in level, that is, a waterfall, for a mass of water to produce hydroelectric power, so we must have a difference in temperature for heat to do work. The maximum efficiency obtainable is completely set by the difference in temperature, divided by the higher temperature. The possibilities and limitations of utilizing solar energy for engines and for house heating have been considered by Professor Hottell (*8*) of MIT. He estimates that an acre of Arizona sunshine might produce 37 kilowatts or 50 horse power and New York sunshine might produce 23 kilowatts or 30 horse power. He concludes that we do not yet have enough facts to determine the economic practicality of solar engines. It may be noted in passing that it usually takes more than one acre of sunshine on farm land to support one horse and that an average farm horse does not work more than 1,000 hours out of 8,766 hours in one year.

Even with expensive lenses or reflecting mirrors spread over a large area, it is not easy, even on cloudless days, to raise the temperature high enough to give very efficient conversion of heat into work; and when the sun is obscured with clouds, a focusing system is inoperative.

Some attempts have been made to operate vapor engines with low-boiling liquids or with water under reduced pressures. These engines are rendered somewhat more practical if they can be located near a large body of cold water to cool the condensers to a low temperature, but the small temperature difference and the low thermodynamic efficiency is a serious handicap.

Windmills are operated, of course, by differences in air pressure caused by solar energy—but, although they are very useful in certain areas, they are sporadic in operation and do not seem destined to play an important role in meeting the demand for large amounts of power.

Let us consider another approach for the direct conversion of heat into work. Thermocouples made by joining two wires of unlike metals will generate electricity when one junction is hotter than the other. We can produce electricity by placing one junction in the sunlight and one in the shade, but the voltages obtainable are of the order of a few thousandths of a volt per junction and, if we use a large number of junctions in series, we automatically increase the resistance of our wires to very large values. On a small scale, intense radiation from the sun can be converted into electricity with an efficiency of a few per cent with expensive equipment. The best commercially available thermocouple material can convert 0.8 per cent of the sunlight absorbed, under favorable conditions, into electricity. Special alloys in the laboratory give promise of a still higher conversion (*16*).

We have photochemical cells which generate electricity when one of the electrodes is exposed to the light and the other is kept in the dark. Again the voltages are very low and the resistances very high so that direct generation of thousands of kilowatts of electricity does not now appear to be practical. For house heating, high temperatures are not required and here seems to lie an opportunity for making more use of the sun. Hot water for houses is now being provided by solar radiation (*3*). Certainly all scientific principles should be followed in the use of absorbing and reflecting surfaces to obtain maximum heat from the sun in winter and minimum heat in the summer. Heat storage beds of cheap, quick, heat-exchanging materials should be more thoroughly explored as a means for equalizing temperature—storing the heat of the day to be blown through the house during cool nights and storing the cold of the night for air conditioning on hot days. An attractive approach lies in the storage of solar heat in chemical or physical changes. Miss Maria Telkes, of the Massachusetts Institute of Technology, is conducting practical research along these lines, and she has summarized the situation with reference to solar house heating (*17*). Lof (*9*) and others have studied the problem of house heating.

Although solar engines for power and mechanical devices for storing solar heat are not impossible, they do not now appear to be practical enough to be important on a large scale. We must look elsewhere for the conversion of sunlight into useful power and stored heat. Let's consider using the sunlight to bring about some cheap, efficient photochemical reaction to obtain a product which we can carry around with us and then release the stored energy when and where we please by a second chemical reaction. It would be a good idea to combine carbon dioxide and water to form carbohydrates and other organic materials and then burn them in the oxygen of the air with the evolution of heat at high temperatures. This sounds like a good idea but there are two serious difficulties—neither carbon dioxide nor water absorb sunlight, and without absorption there can be no photochemical reaction. Even if we found a third substance which would absorb the sun's radiant energy and transfer it in some mysterious manner to the carbon dioxide and water, the energy in the units of radiation, called photons, amounts to only about 40 to 60 kilocalories per mole while the energy required to make carbohydrates from carbon dioxide and water is more than 112 kilocalories per mole. Nevertheless nature solved this problem in a very beautiful manner with chlorophyll and started production of carbohydrates in growing plants soon after the earth cooled enough to permit the existence of organic materials.

This process, in which carbon dioxide and water are transformed into carbohydrates by sunlight in the living plant, is called photosynthesis.

Nature did us another good turn by accumulating this carbohydrate material over millions of years, altering its chemical structure to give a greater percentage of combustible carbon, and storing it, so that we can have convenient fossil fuels packaged as solids, liquids, or gases—coal to be shoveled and shipped in chunks, petroleum to be pumped and carried in tanks, and natural gas to flow easily through pipes.

Again man was provided with a means for getting work done long before he had evolved far enough to invent heat engines. He could obtain mechanical power from the organic material, photosynthesized by the sun, by feeding it directly to men, horses, water buffalo, or other animals, and then persuading them to do his work for him. The conversion of chemical energy into useful work in this intricate animal process is not limited, as heat engines are limited, by the requirement of a large difference in temperature, but by other factors not yet fully understood.

TABLE 1

TYPICAL AGRICULTURAL UTILIZATION OF SUNLIGHT

| Crop | Crop yield/acre/year |
|---|---|
| Corn (1946 average, U.S.) | 33 bushels (0.9 ton)* |
| Wheat (1946 average, U.S.) | 17 bushels (0.5 ton)* |
| Hay, tame (1946 average, U.S.) | 1.5 tons |
| Hay, wild (1946 average, U.S.) | 0.9 ton |
| Florida pine (total wood material) | 3 tons |
| Wisconsin aspen (total wood material) | 2 tons |

* The organic material (cellulose) of leaves, stalks, etc. gives an additional .9 ton, approximately, for corn and 0.5 ton for wheat.

More recently man has tried to compete with nature in using atomic energy under controlled conditions, but the much publicized atomic energy cannot compare with the sun's energy. An atomic bomb with its equivalent of 20,000 tons of TNT has 20,000,000,000 kilocalories, which is no more than the heat of the sunlight which falls on 1½ square miles of land in a day.[1] The difference of course is that in an atomic bomb the energy is wrapped up in a small package and released instantaneously. Only a small fraction of the sun's energy can be utilized in any operation which involves high temperatures.

## Production of Fuel and Food

Of the nearly 2,000,000,000 acres of land in the United States (*13*) a little more than half is used for farming and about a third is forest, the rest being largely grazing land, desert, mountains, and city land. Much of our land, therefore, is now using the sun's radiation to grow vegetation of some kind—crops, forest, or grass—but the utilization of solar energy is often inefficient.

In Table 1 are shown average yields per acre for four crops in the United States for 1946 (*20*).

## Efficiency of Photosynthesis

We have just seen what average yields are now obtained in the conversion of sunlight into plant material and have learned that two tons of wood material can be grown in a year on an acre of aspen in Wisconsin under good operating conditions of continuing forest growth. When this annual growth of wood material is burned, it will yield 8,500,000 kilocalories, whereas the sun's radiation falling on the acre is 7,300,000,000 kilocalories per year. This results in a return of a little less than 1/10 of 1 per cent of the sun's energy.

The case is somewhat better with corn on fertile soil. On some Iowa farms the yield of shelled hybrid corn is 100 bushels per acre and the weight of the cobs, leaves, stalks, and roots is about equal to that of the corn. If all this organic material is burned, about 20,000,000 kilocalories will be evolved, amounting to a conversion of 3/10ths of 1 per cent of the year's solar radiation. If one remembers that the growing season is less than a third of the year, it is evident that the corn actually converts about 1 per cent of the possible radiation into organic material. According to one experiment in which the light was measured and the corn and leaves and roots accurately weighed, a conversion of 1.6 per cent was obtained during the growing season (*11*), or about 0.5 per cent of the year's sunlight.

What are the factors which make for this low efficiency? As just explained, the growing season is short—only about a third of the year. The green chlorophyll of plants does a remarkable job of absorbing light all the way from ultraviolet light to red light at 6,800 A and utilizing it in photosynthesis, but even so it does not absorb more than half of the total range of the sun's radiation. Most of the other half lies in the heat rays or infrared radiation. Again, particularly in the first part of the growing season, the plants are small and much of the acre is not covered with leaves. The layers of leaves are not thick enough to absorb all the absorbable light. Obviously, it is only the light which is absorbed by the plant that can have a part in photosynthesizing new plant material.

In order to obtain the maximum production, all the conditions must be optimum. For example, if sunlight is to be the limiting factor in getting the maxi-

[1] One gram of TNT is equivalent to 1 kilocalorie; 20,000 tons of TNT = $2 \times 10^4$ tons $\times 2 \times 10^3$ lbs/ton $\times$ 453 grams/lb $\times$ 1 kilocalorie/gram = $1.8 \times 10^{10}$ kilocalorie; 1½ sq mi = 960 acres; 960 acres $\times 20 \times 10^6$ kilocalories/acre = $1.9 \times 10^{10}$ kilocalories/1½ sq mi.

mum amount of plant growth, the other necessary major and minor chemical elements must all be present in adequate amounts. For, example, a given amount of sunlight will not give the maximum growth of plant material if the plants are too dry, or the weather too cool, or the ground too poor in soluble, essential minerals. Moreover, when the light intensity is increased, the efficiency of conversion is decreased.

The concentration of carbon dioxide in the air is only 0.04 of 1 per cent, and there is no simple way of increasing this concentration in open fields. All plant material gets its carbon from this 0.04 per cent in the air. This seems to be a small source of carbon for all the vegetation of the world, but in the air over each acre there is 19 tons of mobile carbon dioxide.[2]

What is the theoretical limit to which efficiency in photosynthesis can approach when all other factors involved are present in abundant quantities and sunlight becomes the limiting factor? Under optimum conditions, nearly 10 units of radiation, called photons, must be absorbed by chlorophyll in order to cause the combination of one molecule of carbon dioxide and one molecule of water to give as much carbohydrate as is equivalent to one atom of carbon. These are experimental values, obtained with green algae in water with ample carbon dioxide, perhaps 5 per cent, and plenty of chemical food material and low light intensity. As we shall see shortly, this ratio of 10 photons per molecule means that, with green light, under the most favorable conditions, only 20 per cent of the energy of the light can be stored as chemical energy.

Remembering the 1/3 factor for the growing season and the 1/2 factor for utilizable sunlight, even with the best environment of moisture, fertilizer, and temperature, we could expect to get only 1/6th of 20 per cent or 3 1/3 per cent conversion of sunlight in an agricultural crop in the United States. The 0.3 per cent conversion of the annual sunshine in a bumper corn crop is not bad in comparison with the theoretical maximum of 3.3 per cent.

This maximum ratio of about 10 photons of light absorbed per molecule in photosynthesis has been checked in different laboratories (*10*) in several different ways. The chemical change has been determined by micro-gas analysis, by electrical methods, by chemical titration for oxygen, by differential measurements in a Warburg manometer, and by optical and magnetic methods.

Perhaps the most significant and independent measurements have been made calorimetrically (*1*). A tiny glass cell is surrounded by thermocouples which measure the heat evolved when the light passes through the cell. The light absorbed by algae in the cell is measured at the back of the cell. Of the light which is absorbed by the algae growing under optimum conditions, about 80 per cent is converted directly into heat in the calorimeter, thus leaving only about 20 per cent which can possibly be stored as chemical energy in the carbohydrate and other plant material.

## Mechanism of Photosynthesis

We are just beginning to understand something about the mechanism of photosynthesis. With all the millions of dollars invested in agricultural research, it is strange that so little has gone into the fundamental process of photosynthesis which underlies all of agriculture. Few studies on photosynthesis have been made by federal or state agricultural laboratories, and active programs of work in quantitative photosynthesis has been in progress at only about a dozen universities and institutions.[3] Three symposia on photosynthesis have been held—under the Chemistry Section of the American Association for the Advancement of Science.[4]

The fundamental reaction of all plant life involves the combination of carbon dioxide and water. When a carbohydrate like sugar or cellulose is burned the reaction is represented as follows:

carbohydrate + oxygen = carbon dioxide + water + 112 kilocalories

$$1/n(CH_2O)_n + O_2 = CO_2 + H_2O + 112 \text{ kilocalories}$$

If this reaction is reversed at least 112 kilocalories must be absorbed and, unless the processes are 100 per cent efficient in all their steps, the amount of energy required may be much more. The reaction occurring in the plant is written as follows:

[2] (0.0004 × 15 lbs/sq inch × 43,560 sq ft/acre × 144 sq inch/sq ft) ÷ 2,000 lbs/ton = 19 tons/acre.

[3] Including among others: University of California (isotopic tracers and mechanisms); Carnegie Institution of Washington at Stanford University (plant pigments and photochemical efficiency); University of Chicago (mechanisms, fluorescence, isotopic tracers, and photochemical efficiency); Harvard University (efficiency of forest growth); Hopkins Marine Station (enzyme reactions, photochemical efficiency, and various algae); University of Illinois (general photosynthesis and photochemical efficiency); Iowa State College (absorption of light by leaves); Kettering Foundation at Antioch College (chlorophyll and related plant pigments); University of Minnesota (chlorophyll and related pigments, photochemical electrical cells, isotopic tracers); Smithsonian Institution (influence of color and intensity of light on plant growth); University of Texas (protein production in algae); University of Wisconsin (photochemical efficiency and mechanisms); Massachusetts Institute of Technology (direct utilization of solar energy).

[4] Symposia, AAAS, Section C, Columbus, Ohio, 1939; Gibson Island, Maryland, 1941; Chicago, Illinois, 1947.

$$\text{carbon dioxide} + \text{water} + \text{chlorophyll} + > 112 \text{ kcal} = \text{carbohydrate} + \text{oxygen}$$

$$CO_2 + H_2O + (\text{chlorophyll}) + > 112 \text{ kcal of sunlight} = 1/n(CH_2O)_n + O_2$$

Green light corresponds to 55 kilocalories per mole, and two photons must be brought together to provide this minimum of 112 kilocalories per mole. Red light of 40 kilocalories per mole requires nearly 3 photons per molecule to meet the *minimum* energy requirement of 112 kilocalories. In actual photosynthesis, we have found that about 10 photons are required for one molecule. Now this use by nature of several low-energy photons to do a high-energy job is unique. We haven't done it yet with inorganic materials, and only in the last few years are we beginning to understand how nature does it.

Several laboratory findings have contributed to this understanding. In the first place, earlier theories of photosynthesis were handicapped by the belief that photosynthesis is very efficient, about 60 per cent (*19*) instead of the 20 per cent now accepted. In the second place, important advances have been made recently in understanding enzyme chemistry and the utilization of energy in yeast, bacteria, and other biological systems.

Many miscellaneous facts are known concerning photosynthesis which are helpful in developing a satisfactory theory. Only a few can be mentioned here. Green chlorophyll absorbs the light and acts as the intermediary for supplying the energy from the sun which is required in the complex series of reactions by means of which the carbon dioxide and water combine to give carbohydrate. Chlorophyll has intense absorption bands in the red and blue, but in thick layers it absorbs light throughout most all of the visible spectrum. The maximum efficiency of photosynthesis is nearly the same for red, blue, or green light. Respiration, which is the reverse of photosynthesis, goes on continuously in plants. The plants, like animals, consume oxygen and give off carbon dioxide. The addition of glucose and other soluble organic foods increases the rate of respiration of plants, but it does not affect the rate of photosynthesis.

The ratio of oxygen evolved to carbon dioxide absorbed is often about 1 to 1, but this can be true only for the production of cellulose and other carbohydrates. The ratio cannot be unity in those plants and algae which produce considerable amounts of proteins and fats. An exact determination of the oxygen-carbon dioxide ratio is helpful in giving information concerning the composition of the organic materials produced in photosynthesis.

The photo reactions pile up fresh organic material, which is used by the plant in a series of reactions which go on in the dark. Valuable information concerning the dark thermal reactions and the photo reactions has been obtained by exposing plants to intermittent light with dark periods ranging down to fractions of seconds (*6*). Again the dark and light reactions can be partially distinguished by changing the temperature because the dark reactions are accelerated by an increase in temperature whereas the photo reactions are nearly independent of temperature.

One of the newest and most promising attacks on the mechanism of photosynthesis lies in the use of isotopic tracers. When plants are grown in carbon dioxide which contains radioactive carbon, the first chemicals produced in photosynthesis are identifiable by means of their radioactivity. Active and significant work is now going on with radioactive carbon (*14*). Experiments with water containing the heavy isotope of oxygen revealed the significant fact that the oxygen released in photosynthesis comes from the water (*15*) and that the oxygen of the carbon dioxide remains in the plant materials.

With the help of these laboratory findings and many others, a satisfactory hypothesis is beginning to unfold. Following the primary photo reactions are many thermal reactions which are aided by enzymes. The over-all energy requirement of more than 112 kilocalories is too great to be met by one unit of light, one photon, and the reaction must be carried out in a series of steps, one photon being used for each step.

Apparently the carbon dioxide adds to an organic substance of low molecular weight and forms a carboxyl or acid group. This new substance is subsequently reduced by hydrogen made available through the photochemical dehydrogenation of water. Perhaps four steps are involved, each requiring a photon; and then four more reactions with four more photons are required to restore the hydrogen atoms to these intermediate compounds, ready to be used again. This gives a total of eight photons through a series of eight intermediate steps, which carry the hydrogen from the water to the carbon dioxide, thus releasing oxygen and forming the carbohydrate material, $CH_2O$. If this picture, proposed by James Franck, of the University of Chicago, is correct we have a plausible explanation for the experimental fact that about ten photons are required.

## The Next Hundred Years

When it comes to predictions, the news reporters probably take delight in pushing the scientist out on a limb—just to see the splash. However, on this 100th anniversary there may be a legitimate demand for a little speculation.

The days of easy geographical quest for more food, fuel, and power are over, and our frontiers now lie

in science and engineering. We can no longer afford to waste valuable fuel in fireplaces and stoves that send most of the heat up the chimney nor in low temperature engines that are thermodynamically inefficient. An *average* steam locomotive converts not much more than 5 per cent of the heat of the burning coal into useful work. In the future, it will be necessary to increase the efficiency of our utilization of sunlight, to conserve all our resources, and to control the birth rate of the world's population. We have seen that we are now using only a small fraction of the solar energy which is available and that, theoretically, we should be able to appropriate a much greater part of it. We have seen that present prospects are not bright for the conversion of solar energy into electrical power through heat engines, thermocouples, or photochemical cells, but revolutionary discoveries might well lead to more optimistic possibilities.

Our discussion has emphasized the situation in the United States because it was difficult to obtain statistical information regarding the utilization of sunlight over the whole world. We are emphasizing on this anniversary occasion, however, that science is worldwide. Let us add, then, that the area of the United States is but a small fraction of the earth's surface and that any improved conditions must be thought of in terms of world application. In the tropics there is a greater opportunity for utilizing solar energy because the energy is greater than the 1 kilocalorie per square foot per minute in the United States and the growing season is not confined to a third of a year. The soil and certain agricultural conditions are somewhat less favorable however. Also to be considered are the great areas covered by oceans where photosynthesis goes on in diatoms and other sea plants. Perhaps more organic material is being produced now in the sea than on the land.

It is possible now to grow plants without soil, using barren sand or tanks of water containing the necessary chemical elements. This science of hydroponics has been developed to a point where such operations are practical, even if not economically competitive except in special areas. Probably the utilization of sunlight can be made more efficient in this way and the operation can be applied where there is no soil suitable for ordinary farming.

Let's consider one step further. What chance is there that we can combine carbon dioxide and water to give organic material without the agency of a living plant? We can perhaps find some combination of colored dyes and enzymes which will do what nature now does with green plants? This has not been done yet, but there is no obvious theoretical reason why it cannot be done some time in the future. As a matter of fact, if someone had asked me to guess ten years ago which would come first, atomic energy or photosynthesis without the living plant, I would have guessed the latter. But now we have atomic energy —or at least we *can* have it. It resulted from the unexpected discovery of fission, an investment of five years of intensive cooperative research by many hundreds of scientists and engineers, and the expenditure of $2,000,000,000. The corresponding investment in photosynthesis has been negligible. A really large program of research on the greater utilization of solar energy might produce significant developments. Solar energy is our most promising resource in the long-range view.

There is no assurance that photosynthesis outside the living plant will be any better or cheaper than present photosynthesis in plants. Very likely agricultural research similar to that already carried out will provide our best means for increasing the efficiency of our utilization of solar energy where the soil is good.

Even if we could produce food without the growing plant, our present farms would not fear competition from the cheap land and bright sunshine of Arizona. Any type of artificial photosynthesis would probably require shallow tanks, possibly of concrete covered with glass, and the investment would be too great to consider in economic competition. Moreover, any possible development of this kind would come slowly enough to give ample time for economic and social readjustment. Scientists of the future should consider photosynthesizing organic or inorganic products of an energy content lower than cellulose and carbohydrates. It might be easier. Possibly they might tackle the problem of muscular action produced by chemical reactions involving photosynthetic material, thus attempting to follow the pattern of animal work. There are serious limitations in efficient conversions of food energy into animal work, but they are perhaps less well defined than the second law of thermodynamics, which limits the efficiency of heat engines.

Looking less far into the future, what important changes are apt to come? We shall have to find ways to increase the food and fuel supply of land areas which are not now suitable for growing standard food crops. The wheat and meat of the limited, rich farming lands cannot be used indefinitely to feed the world. Trees and quick-growing bushes and grass can be grown on poorer soil, and it is now perfectly practical to eat wood products. In fact, thousands of tons of wood yeast were used for human food in Germany during the war. Sixty-five to 70 per cent of most woods can be converted into sugars by heating with dilute sulfuric acid to 120°–150° C under special conditions (*7*) developed at the U. S. Forest Products Laboratory. This material can then be used for growing yeast and producing alcohol which can be used

for liquid fuel. The wood yeast is as rich in proteins as beef steak and can be used for food.

These cellulose yeasts are cheap, and they possess splendid nutritive value. With intensive research on improving the flavor, this source of protein should be of great help in solving a food shortage, particularly in the tropics, where the large-scale production of meat is difficult. Nitrogen compounds must be supplied to these growing yeasts in order to produce proteins. Possibly this fixed nitrogen can be supplied directly from the nitrogen of the air by a new process in which the air is heated to a high temperature. Present methods of utilizing sunlight to increase proteins include the feeding of plant material to chickens, hogs, and cattle. Fish farms should probably be expanded in certain areas. Intensive research should be directed toward utilizing diatoms and other sea plants as food. They can be hydrolyzed to produce sugars that can be used directly or as a means of producing edible proteins from yeast. The supply of aquatic vegetation in the oceans is enormous; and in fresh-water lakes and streams the algae and weeds should be harvested anyway because they are often a nuisance.

The utilization of farm products for local fuel is another development that can be around the corner, but the present cost of harvesting bulky, low-value products is high. If farm prices fall it may be more difficult for the farmer to pay cash for gasoline and oil for the tractors that have replaced the hay-eating horses. Wood and corn stalks and other cellulose material have been converted into alcohol—60 gallons to the ton. New developments of the Fischer-Tropsch synthesis of hydrocarbons assure us that it will be possible to convert waste organic material into carbon monoxide and hydrogen, which, with the help of iron and cobalt catalysts, can be converted into hydrocarbons and satisfactory motor fuels. Research should be directed toward developing medium-sized units for farm areas. It must be determined under what conditions part of the farm products should be used for fuel and returned to the land to improve the soil.

Some of these developments that I have suggested will come slowly, not because of technical difficulties, but because of economic circumstances. For the present, nature has supplied man with such abundant sources of fuel and food that he will not be pushed to these new things for some time unless there continues to be unequal distribution among the nations of the world due to war and political short-sightedness. It is comforting, however, to know that we can get more from the sun when we need it and that, theoretically at least, the scramble for oil and coal could be eased.

Science must go forward, regardless of immediate practical applications, accumulating a reserve stock of knowledge that can be used in any emergency. We must learn how to use our rich heritage of sunlight more efficiently so that we can be prepared against such catastrophes as war, overpopulation, exhaustion of oil and coal, and the return of the glaciers (*4*). The scientists, too, must cooperate with the social scientists and statesmen so that adequate preparations can be made for any social, economic, and political readjustments that may follow the scientific developments.

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# Uranium Deposits in the USSR

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CONTRARY TO POPULAR IMPRESSIONS, a fair amount of authentic information has been published on the uranium resources of the Soviet Union. Because of widespread interest in this subject, I believe it worth while to summarize the pertinent facts.

According to Vernadskii (*26*, especially pp. 56–70), Russian research on radioactive minerals began in 1900–1903 with the work of I. A. Antipov in the Fergana Valley (40° to 41° N, 70° to 73° E) of Russian Central Asia. Beginning in 1909 the Imperial Academy of Sciences initiated more ambitious investigations. All previously gathered information was sifted carefully, so that field work in 1911–1913 could be concentrated on the most promising localities: the Fergana Valley, Siberia, the Caucasus, Transcaucasus, and Urals. By 1914, indications from the Caucasus and Transcaucasus had become negative. In the Urals no indication of deposits of sufficient size for commercial exploitation could be found. Two areas appeared promising. One was Tyuya Muyun (40° 21′ N, 72° 0′ E) in the Fergana Valley, with deposits of *tyuyamunite*, $Ca(UO_2)_2 \cdot V_2O_8 \cdot 6\,H_2O$, closely comparable to the carnotite of the American southwest.[1] The other was the northwest slopes of the Khamar-Daban Range (51° to 52° N, 103° to 106° E), especially near Slyudyanka (51° 40′ N, 103° 35′ E) and along the Trans-Siberian railroad between Baikal and Kultuk immediately across Lake Baikal, characterized by sites rich in *mendelyeevite*, with the probable composition, $2\,CaO \cdot 2(Ti, U)O_2 \cdot (Nb, Ta)_2O_5$, strikingly similar to betafite and allied niobium-tantalum-uranium minerals of Madagascar.[2]

In 1914, a three-year program of research was authorized for the Academy of Sciences. The largest sums were to be devoted to expeditions in the Baikal area and the Fergana Valley, with lesser amounts going for investigations of the placer monazite deposits of the Transbaikal and for various minor projects (*26*, pp. 71–80; *10*, pp. 15–16). While World War I prevented full accomplishment of the program of the Academy of Sciences, enough was done to establish that only the Fergana Valley and the Baikal area had possibilities of commercial development (*10*, p 15–16). By 1918, the new Soviet government beg pressing for the resumption of laboratory and fie investigations of radioactive minerals; on January 1922, scattered radiological facilities in the USS were combined in the Governmental Radium Institu of the Academy of Sciences, headed by V. I. Ve nadskii (*10*, pp. 19–35).

This new Institute concentrated its efforts on th site of Tyuya Muyun. An important reason for th decision was the fact that small-scale commerc operations had been begun there in 1908. Betwe 1908 and 1913 the Fergana Company had mined 088,000 pounds of ore, 1,512,000 pounds of which h been sent to its plant in Leningrad for refining. Ac cording to Company records, the ore contained, on th average, 2.36% V, 0.97% $U_3O_8$, and 3.73% Cu ( p. 19). Scientific study of Tyuya Muyun and the su rounding area, which had been conducted sporadica since 1914, was pressed throughout the decade 192 1934. Detailed investigations and construction of e ploratory and operating shafts permitted analyses the site by Fersman (*4*) in 1928, Kirikov (*12*) i 1929, Pavlenko (*19*) in 1933, and Butov and Zaits (*2*) in 1934.

The Tyuya Muyun deposit is a vein field in high metamorphosed Paleozoic limestone, closely—but pro ably not genetically—associated with extensive ka channels and caves. The vein field consists of at le five (1933) barite ore veins bearing uranium, v nadium, and copper minerals and of over 30 p barite veins. The productive veins are found near t center of the deposit, being located along a line co forming with the NE 70° strike. The barite vei extend up to 1,500 meters from the center; the ma mum depth of the main vein may reach 500 mete (*12*, especially pp. 63–5, *19*).

The ore bodies within the productive veins vary thickness from 1.5 meters to a few centimeters, a correspondingly in length. Run-of-the-mine ore av ages 1.5% $U_3O_8$, with a range of 0.6 to 4.0%, t higher values being found in the lower horizo However, the uranium oxide content of the amo phous, brown, cupro-uranium carbonate lenses as ciated with the karst stalagmitic core runs from 26 to 50.25%. Also noteworthy are the uranium-fr radiobarites—$(Ba, Ra)SO_4$—and radiocarbonate $RaCO_3$—established in relatively high concentrati at both lower and upper horizons of the deposit

[1] Fersman (*4*, p. 47) and Kirikov (*12*, p. 42) give an alternative analysis, $V_2O_5 \cdot 2\,UO_2 \cdot CaO \cdot nH_2O$. The replacement of the $Ca^{++}$ by 2 $K^+$ gives the formula of carnotite, cf. Betekhtin (*1*, p. 234).

[2] This affinity was recognized by V. I. Vernadskii in 1914, cf. *15*, p. 236; see also *6*, p. 279, and for betafites, *13*, I, 365–392.

12). The irregularity of the Tyuya Muyun deposit has made impossible the estimation of reserves; the mine produced 534 metric tons of hand-sorted ore in 1925–26 (*7*, pp. 571–573). By 1936, according to Nikitin (*18*), the quantity of radium extracted from the Tyuya Muyun ores and from radioactive waters near Ukhta (approximately 63° 35′ N, 53° 40′ E) was enough to meet the needs of the Soviet Union.

The origin of the Tyuya Muyun deposit is highly controversial. Careful examination of the literature has led the writer to believe that (1) the original source of the uranium has not been satisfactorily established; (2) that deep, relatively low-temperature, hydrothermal processes, possibly connected with the Variscean revolution of the Upper Paleozoic, appear to have been the primary agents of deposition; (3) that subsequent orogenic movements (Alpine?) faulted the deposit; (4) that the post-Eocene karst redistributed the deposit, partly destroying veins, partly reconcentrating ores. Interesting parallels may be found with the Ukhta radium-bearing wells, particularly in regard to the high concentrations of radium, mesothorium, and barium (*3, 5*).[3]

Explorations in other parts of the Fergana Valley have also been undertaken. In 1928, numerous indications of intense radioactivity were discovered in the western part of the Valley, but no uranium deposits (*22, 23*). In 1923, however, V. I. Popov published an account of the discovery of a uranium deposit at Uigar-sai or Atbash (41° 02′ N, 71° 12′ E) on the northern side of the Fergana Valley. Geologically, the site was said to be closely similar to carnotite deposits in Colorado and Utah. It is characterized by young, stream-deposited lenses of urano-vanadium ore, some of considerable size and richness. "In terms of its high percentage of content, dimensions of individual ore bodies, and probable reserves, the urano-vanadium deposit discovered at Uigar-sai does not yield to many carnotite sites in the U. S. A. The deposit is found under very favorable economic conditions, being situated at an automobile road; it is to undergo survey in 1939" (*21*).

Volfson's comprehensive survey of metallogenesis in the western Tian Shan range (*27*) also gives brief details of other newly discovered deposits at Taboshar (40° 37′ N, 69° 39′ E) and Maili su (41° 18′ N, 72° 27′ E). In the first of these, which has also been described by Mashkovtsev (*16*), uranium pitch (pitchblende?) is associated with bismuth glitter, wolframite, arsenopyrites, and sulfide polymetallic (lead, zinc) deposits. According to Mashkovtsev's preliminary report of 1928, the indicated uranium content of the ore is only of the order of 0.12–0.2%, which probably deprives it of economic significance. In the second site, infiltrations of urano-vanadium compounds are associated with tertiary limestones. Neither site was being commercially exploited in 1940 (*27*).

In evaluating the significance of the Central Asiatic sites, it should be noted that, according to the Soviet prospecting plan for 1940, search for uranium and radium was to be concentrated in that area (*8*).

Two other recent finds of uranium-vanadium ores in Central Asia may be mentioned. In 1937, Gotman (*9*) published an account of the deposit at Agalyk (39° 32′ N, 66° 52′ E); petrographic analysis of surface finds here established that tyuyamunite was the most frequently occurring ore. The geology of the site remained unclear; some evidence of primary deposition existed, but secondary hydrothermal deposition could not be excluded. Sampling at groundwater depths (50–60 m) would therefore be necessary to establish the potentialities of the site; no data are available as to whether such sampling has been undertaken. In 1940–41, the presence of uranium was established by Tyurin (*24*) in a vanadium site in the northwestern tip of the Karatau Range (44° 30′ N, 67° 30′ E). It represents a sedimentary deposit with subsequent metamorphism which has created a reiterated interbedding of thin bands of vanadium ores (with uranium-mineral accumulations) with flint bands. The total amount of uranium in the ore body (which extends for 25–30 km, with a thickness of 10–14 m) is great; but the improbability of finding large pockets of uranium and the difficulty of separating the disseminated uranium from vanadium on a large scale are serious obstacles. According to Tyurin, the preliminary surveys of 1942 should be followed by more extensive explorations of the area.

In the area of the Khamar-Daban Range, serious investigations have been undertaken only at Slyudyanka, which is significant as a phlogopite mica deposit. Luchitskii and his collaborators (*15*, pp. 74–95, 146–7, 236) verified the presence of mendelyeevite and established the existence of two phases, crystalline and amorphous, with differing compositions and physical properties. For instance, two analyses of the crystalline phase yielded 36.75% $Ta_2O_5$ and no $Nb_2O_5$; 14 analyses of the amorphous phase, 39.46% $Nb_2O_5$ and 3.82% $Ta_2O_5$. Total uranium-oxide content in all samples ranged from 19.70 to 28.90%.

From an economic standpoint the results at Slyudyanka seem to be negative for mendelyeevite was found only in the pegmatite veins of two parts of the deposit, in which it appears generally to play a subordinate role. The productive sector (Zayavka No. 5)

[3] This interpretation is supported by L. A. Osipov's (*Sovietskaya Geologiya*, 1941, No. 3, 36–48) association of the Fergana uranium deposits as a group with Paleozoic oil-bearing marine formations.

consists of a large mass of Pre-Cambrian crystalline limestones, penetrated by a 200-meter-thick band of biotite and biotite-granitic gneisses, which in turn are interlaced—in places, virtually engulfed—by the thick pattern of pegmatite veins in which mendelyeevite has been found. The bulk of the phlogopite veins of the sector are associated with the pegmatite-gneiss zone of contact.

Despite the seemingly negative picture at Slyudyanka, the widespread development of formations closely resembling the productive sector of this deposit from the Sayan Range (approx. 50° N, 100° E) northeastward to the Aldan gold fields (approx. 58° N, 125° E) cannot be ignored (*6*, pp. 382–3, 467–9, 552–560). A genetic association may exist between niobium-tantalum-uranium ores and phlogopite mica; their immediate proximity at Slyudyanka and their relative proximity in Central Madagascar (Volonandrongo and Ambatofotsy) raise unanswered questions.[4] Thus the discovery of three major phlogopite mica deposits in the Aldan gold field area—Emeldzhik (approx. 58° 22′ N, 126° 40′ E), Kuranakh (58° 46′ N, 125° 35′ E), and Chuga or Ust Nelyuka (58° 06′ N, 123° 0′ E)—heightens the probability of corresponding uranium finds to an unknown degree (*20*).

Finally, it should be mentioned that Fersman (*6*, pp. 480–484, 579) attached great importance to further study of the Ukrainian magnetito-ortite pegmatites, particularly in the areas of Novograd Volynskii (50° 30′ N, 27° 40′ E) and Berdyansk-Mariupol' (46° 40′ N, 36° 50′ E to 47° N, 37° 30′ E). He emphasized the likelihood of large, unexpected discoveries of Nb, Ta, U, Ti, and other minerals in these areas.

In brief, Soviet discoveries of uranium in Central Asia within the last decade, while in no sense approaching the great significance of the African and Canadian deposits, appear to provide a possible basis for the development of atomic power in that area. It must be stressed that all of the Central Asiatic deposits are found within a radius of 250 miles from the important hydroelectric plants of the Tashkent area, which produced 882,000,000 kilowatt-hours of energy in 1943 (*28*, p. 53). Labor, transportation, and climatic conditions are also favorable here.

[4] See *13*, I, pp. 365–392, 474–476; II, pp. 122–135, 145–147.

Possibilities for the discovery of significant uranium deposits associated with pegmatites in the region between Lake Baikal and the Aldan gold fields, and in the Ukraine, also exist.

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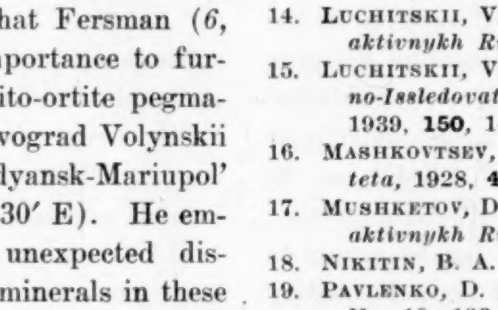

# TECHNICAL PAPERS

## Pentavalent Manganese[1]

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In fused alkaline melts, the lower oxides of manganese react with oxygen until an oxygen-to-manganese ratio of about 2.5 is established (*5*). For aqueous media, reliable evidence pointing to the existence of pentavalent manganese has only recently been reported (*4*). The present paper will show that such a valence state can be detected polarographically in strongly alkaline solutions.

A solution containing $1.00 \times 10^{-3}$ M potassium permanganate and 0.10 M sodium hydroxide was deaerated with nitrogen and then polarographed, using a stationary platinum electrode (*6*) and an outside saturated calomel electrode (S.C.E.). The resulting curve is shown in Fig. 1.

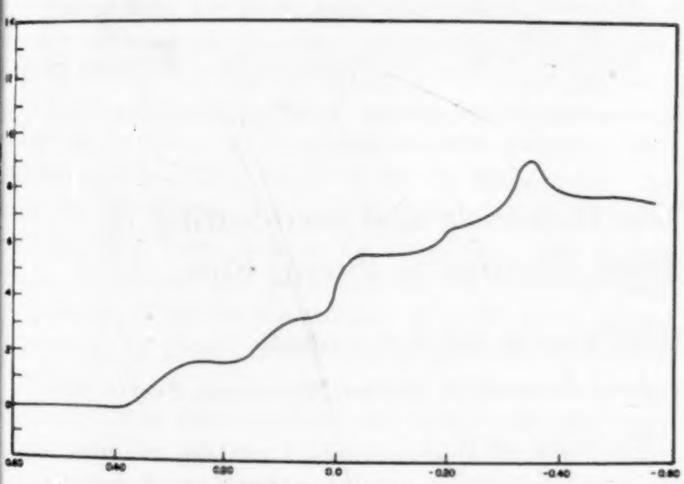


FIG. 1.

The first step of the reduction ($E_{\frac{1}{2}} = +0.33$) has a diffusion current corresponding to a one-electron change (for the particular electrode which was employed) and a formal oxidation potential of $-0.58$ v, versus the normal hydrogen electrode. Since the permanganate reaction has a normal potential of $-0.54$ v (*2*), the first wave can definitely be assigned to this reaction. The second ($E_{\frac{1}{2}} = +0.13$ v) and third steps ($E_{\frac{1}{2}} = +0.01$ v) also have diffusion currents corresponding to one-electron changes. Hence the reactions taking place must be $Mn^{VI} \rightarrow V$ and $Mn^{V} \rightarrow IV$. The fourth (and last) step beginning close to $-0.2$ v must be due to the reduction of $Mn^{IV}$. The irregularity of the step can easily be explained by the fact that the electrode is covered with a visible layer of precipitated manganese dioxide.

[1] This work was performed under contract No. W-35-058-eng.-71 between the Atomic Energy Commission and the Monsanto Chemical Company.

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There is indirect evidence that the lifetime of pentavalent manganese in 0.1 M hydroxide is not more than a few minutes. The polarographic half-wave potentials and and diffusion currents appeared to be independent of the rate at which the motor-driven slide-wire changed the voltage. On the other hand, a current-voltage curve obtained by a manual method (*1*) resulted in a single broad wave. It was not surprising, therefore, that an attempt to produce pentavalent manganese by electrolysis of manganate at a suitable potential (*3*) produced a large amount of manganese dioxide. The solution had a bluish color (similar to chromous sulfate) which agrees with the work of Lux (*4*).

Preliminary studies have also been made in other concentrations of sodium hydroxide. In a 1.0 M solution, the polarogram is very similar to the one described for a 0.10 M solution; but in a 0.010 M solution, the manganate is reduced directly to manganese dioxide in a single two-electron step. A more complete study of changes in half-wave potentials with the concentration of hydroxide will be necessary before the reactions of the $Mn^{V}$ ion can be described accurately. The results of such a study will help in predicting the behavior of technetium ions.

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## Note on the Genetics of Hypercholesterolemia

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An important aspect of the expanding interest in human genetics is the detection of carriers of hereditary diseases, both in the sense of normal heterozygotes of recessive defects, as in some forms of epilepsy (*4*), and in the sense of those individuals who exhibit some predisposing condition without showing the characteristic symptoms of the disease, e.g. hyperuricemia in gout (*7*). It is elementary in all cases to determine on the basis of numerical tests the mode of inheritance, the gene frequency, penetrates, and so on. Boas, *et al.* (*1*) have

recently published data on hypercholesterolemia, a disturbance of cholesterol metabolism which "may be the common denominator in most patients who have coronary artery disease." At Boas' suggestion and with his kind permission, the following analysis of their data was undertaken. These authors studied the families of patients chosen because they had proved coronary artery disease, the symptoms of which began before the age of 50. Fifty families yielded 37 families which could be used for a numerical test of the mode of inheritance, because they included more than one child in each family and at least one sibling per family was affected with hypercholesterolemia. Study of these 37 families revealed 11 families of 2 children, with 14 affected; 10 families of 3 children, with 22 affected; 10 families of 4 children, with 19 affected; 2 families of 5 children, with 6 affected; and 4 families of 6 children, with 6 affected; giving a total of 67 affected out of 126 children. When the number expected to be affected for these 37 families is calculated on the basis of a 1:1 ratio, using the corrective factors for small family size given by Hogben (*3*), for hereditary characters with complete penetrance, the result is 70.5 expected affected, with a standard deviation of 4.8.

This is clearly an excellent fit to a 1:1 Mendelian ratio, which is obtained in the case of a dominant trait when one parent is heterozygous for a dominant defective gene and the other parent is homozygous for the recessive normal allele, or which is obtained in the case of a recessive trait when one parent is homozygous for the recessive defective allele and the other is heterozygous normal. Since the data do not include the parents, a decision can be reached only tentatively as to which one of these two possibilities is a priori more probable. Data somewhat similar to those of Boas, *et al.* have been obtained and analyzed by us for the inheritance of Heberden's nodes (*6*) and hyperuricemia (*8*), in comparison with similar cases in the literature which were shown more conclusively to be due to autosomal dominance. We are thus led to the conclusion that hypercholesterolemia is an autosomal dominant trait with complete or nearly complete penetrance. As in research on many other hereditary conditions, the gene frequency, linkage relations with other genes, and confirmation of its mode of inheritance as a dominant with complete penetrance require further investigation.

Boas, *et al.* arbitrarily selected a concentration of 300 mg/100 ml as indicative of hypercholesterolemia, purposely choosing a high level to eliminate the influence of minor elevations. This happy choice has been entirely justified by the data of Peters and Man (*5*), who, in a study of 174 determinations in normal individuals, found an average serum cholesterol of 194.1 mg ± 35.6 mg/100 ml. Three times this standard deviation above the mean gives a limit of normality of 300.9 mg/100 ml. Such a figure, that is, would allow only 1 or 2 persons in 1,000 to be above 300 mg and still be classified as normal in cholesterol concentration in the blood serum.

Certain people with hypercholesterolemia may be considered to exhibit a genetic trait characterized by this chemical abnormality. It is not at all certain that the genetic form of this abnormality can be identified by one chemical determination without regard to age, sex, diet, or other conditions of metabolism which may elevate the level temporarily—any more than one blood sugar determination identifies unqualifiedly a diabetic, or one uric acid determination identifies a gouty individual. Further investigation may reveal hypercholesterolemia as an inborn error of metabolism (*2*) similar to gout, albinism, cystinuria, or pentosuria, which are definitely dependent upon genetic factors. Constitutional hypercholesterolemia may offer an organic explanation for some cases of familial angina pectoris and coronary artery disease, as well as familial xanthelasma and xanthomatosis.

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## The Flowering and Seed-Setting of Sweet Potatoes in Puerto Rico

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The work of Hartman (*3*) reporting complete failure of flower formation in Jersey-type sweet potatoes and the more recent work of Mikell, Miller, and Edmond (*4*) have prompted us to report certain observations on the flowering of sweet potatoes in Puerto Rico.

Thirteen of 16 varieties grown in field plots at the Federal Experiment Station flowered during the fall and winter of 1947–48. These were grown from sprouts set in the field in July. Plants were trained up on 6' chicken-wire trellises and were kept thinned by constant pruning, following the methods of Miller (*5*). It was not found necessary to girdle the plants.

Among the varieties which flowered was one of the difficult-to-flower Jersey types, Orange Little Stem. Two out of three plants of this variety included in the trials began to flower early in December and continued through the middle of January.[2] These flowers opened at the same hour and were very similar in appearance to the flowers of other varieties. Microscopic examination of

[1] Administered by the Office of Experiment Stations, Agricultural Research Administration, U. S. Department of Agriculture.

[2] It may be reported that this variety again started flowering in August 1948.

the pollen showed it, also, to be similar to that of the other varieties, with considerable variation in size and many shrunken grains. Anthers and stigmas were normal and functional, except in one or two flowers, where the anthers failed to dehisce and appeared to be sterile. In all, a total of about 50 blossoms were produced, generally one or two per day, and these on particular branches. Three plants of another Jersey variety, Maryland Golden, grown similarly failed to flower.

One hundred fifty-three crosses were made, using Orange Little Stem as the pollen parent and various of the moist-flesh varieties as female parents. Of these, only 6, or 3.9% (involving B-5928, UPR-3, Don Juan, and Mameya), were successful and set seed. This is a low percentage of set but compares favorably with 492 crosses made at the same time among moist-flesh varieties, of which only 17, or 3.5%, were successful. Seeds also were obtained from several open-pollinated Orange Little Stem flowers, thus proving this variety to be both male- and female-fertile. The open-pollinated and hybrid seeds were sent to Dr. C. E. Steinbauer, at Beltsville, for germination, distribution, and testing under a cooperative sweet potato-breeding agreement.

It is of interest that W. K. Bailey, working at this station more than 10 years ago, also reported flowering in Jersey varieties (*1, 2*). He brought Big Stem Jersey, Vineland Bush, and Yellow Jersey into flower and succeeded in crossing the first two of these with moist-flesh varieties. Moreover, at least some of these crosses produced offspring. This early work of Bailey and the production of flowers by Orange Little Stem here at Mayaguez this past season indicate that the Jersey varieties will flower and probably are not fundamentally very different from the moist-flesh varieties, with regard to flowering, if grown under the proper environmental conditions.

The conditions under which the Jersey varieties have flowered here are: (1) an average annual rainfall of 80″ which falls off from a high of 11″ in August to 2.5″ in December; (2) a mild temperature, with average maxima and minima for August of 90° and 68° F, respectively, and for January of 86° and 62° F, respectively; (3) a day length which varies from 13.2 hrs in June to 11.0 hrs in December, with a yearly average of about 8 hrs of sunshine per day. Under these conditions, sweet potatoes behave as perennials and grow throughout the year.

Most moist-flesh varieties flower and seed profusely in Puerto Rico. This past season, plants of B-5988 and Mameya frequently produced 50–100 new blossoms each day and were literally covered with seed capsules. It is also of interest that some of these varieties appear to lose their seasonal flowering response in Puerto Rico. The varieties B-5928, UPR-3, and Mameya, which began flowering in November, 1947, did not return to a vegetative state at the end of the usual flowering period, but continued to flower during the spring and summer months. This flowering was not as profuse as during the fall and winter, but some buds and flowers were in evidence continually.

Other Jersey varieties, including Yellow Jersey, Red Jersey, Big Stem Jersey, and Vineland Bush, and the new wilt-resistant introductions, 153655, 153907, and 153909, have been included in the breeding project for the coming season. This station will cooperate with the Division of Vegetable Crops and Diseases of the Bureau of Plant Industry, Soils, and Agricultural Engineering, at Beltsville, and the sweet potato breeders of the southern states in an attempt to combine the desirable root characteristics of the Jersey varieties with the vigor, high carotene content, and fusarium wilt resistance of some of the moist-flesh varieties, through hybridization.

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## Influence of Texture of Food on Its Acceptance by Rats


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It is known that rats often eat only the germ part of whole kernels of corn and leave the starchy part when sufficient corn or other food is available. The gnawing out of the germ part of corn by rats usually seems to be so precise that it has been regarded as a reliable method of determining the proportion of germ in kernels of corn and also as evidence of a high "nutritional I. Q." in rats. Some rats, nevertheless, eat the white starchy part of kernels of corn as well as the germ part but still leave the flintlike yellow part of the kernels and separated skin, which obviously has a considerable "edge resistance." It therefore appeared possible that the rats ate the germ part or germ and white starchy part of corn because these parts are of softer texture than the yellow part and skin.

To test this possibility further, 12 rats on an otherwise adequate diet and in separate cages were provided on alternate days with a supplement of dry kernels of corn and one with kernels that had been soaked in water at room temperature from 24 to 48 hrs. In practically all instances the rats ate all but the skin of the soaked or softened kernels of corn, while only the germ part or germ and white starchy part of the dry or hard kernels was eaten. It seems doubtful that a diffusion of tasty substances throughout the kernels of the corn, as a result of soaking in tap water, explains the difference in the parts consumed. It is more likely that soaked corn is less tasty than dry corn, but soaking evidently makes kernels of corn more completely edible.

The influence of the texture of food on its acceptance by rats was also noted by us in previously reported studies. Thus, in a study on rats fed vegetarian self-selection diets (*1*), it was found that no dry green peas

or dry soybeans were eaten, but, when they were provided in the soaked or softened state, substantial amounts of peas (excepting the skin) and some soybeans were eaten. In a study of the effect of the addition of various types of bulk-formers to the diet of rats (2), it was also found that the food intake was influenced considerably by the texture of the added bulk-former. Thus, the growth of young rats, particularly females, was retarded much more by the addition of 10% ground cellophane (40 mesh) to the diet than by the addition of 10% cellu- lose flour (Cellu Flour). The acceptance of food by rats, like the acceptance of food by man, is therefore influ- enced more or less by the texture of the food.


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## The Influence of Brief Periods of Strenuous Exercise on the Blood Platelet Count


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Reports in the literature on the effect of exercise on the blood platelet count have been conflicting. Behrens (1) found that rowing over a course 6 km long or running a distance of 200–400 m always caused an increase of 18–20% in the platelet count of trained and untrained men. Isaacs and Gordon (3) estimated that the number of platelets was increased 2–3 times after a race lasting 2.5–3 hrs over a 26-mile course. Biggs, MacFarlane, and Pilling (2) observed platelet increases of approximately 20–40% in subjects running up flights of stairs for periods of 2–12 min. Kristenson (4), on the other hand, found no significant change in the platelet count after exercise of moderate intensity that lasted 1.5–9 hrs. Differences in the type and duration of the exercise and in the technique of collecting the blood and making the platelet counts may account for these discrepancies. Our experience in counting platelets has convinced us that counts are unreliable unless they are made quickly after the sample is obtained and that the importance of meticulous technique cannot be overemphasized. The data in this paper represent a large number of platelet counts on one subject, in moderately good training, who performed at two standardized grades of exercise.

The exercise consisted in running on a treadmill for 5 min at a speed of 7 mph and a grade of 17.5% (strenuous exercise), or for 2 min at 12 mph, zero grade (exhausting exercise). The severity of the exercise was judged on the basis of the subjective impressions of the subject and the magnitude of the leucocytosis. The platelets were counted in a certified counting chamber using the diluting fluid of Rees and Ecker (6). Daily blank counts were made on the diluting fluid in order to avoid artifact errors. Leucocyte and erythrocyte counts were also made in most of the experiments. In each experiment platelet counts were made on blood samples obtained before exercise, immediately after exercise, and at intervals of 10, 30, 60, and 90 min during the recovery period.

The data on the platelet counts are recorded in Table 1. The data on leucocyte and erythrocyte counts are omitted because they are in accord with previous studies on exercise of comparable intensity (5). It is apparent that there was no increase in the platelet count in short periods of exercise.

TABLE 1

EFFECT OF BRIEF PERIODS OF EXERCISE ON THE BLOOD PLATELET COUNT*

| No. of experiments | Intensity of exercise | Blood platelets (thousands/mm³) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Pre-exercise | Minutes postexercise | | | | | |
| | | | 0 | 10 | 30 | 60 | 90 |
| 13 | Strenuous | 213 ± 15 | 208 ± 19 | 205 ± 18 | 201 ± 17 | 195 ± 18 | 196 ± 19 |
| 3 | Exhausting | 212 ± 13 | 198 ± 18 | 197 ± 17 | 200 ± 10 | 195 ± 15 | 197 ± 12 |

* The duration of the periods of strenuous exercise was 5 min and of the periods of exhausting exercise 2 min.

The lack of increase in the platelet count in these experiments, in spite of increases of 60–100% in the leucocyte count, may be interpreted as evidence against appreciable storage or sequestration of platelets. The extreme fragility of platelets, however, renders them readily susceptible to mechanical trauma, and it is possible that the greatly increased circulation velocity during exercise may destroy enough platelets to mask a moderate increase in numbers. The small postexercise decline in platelet count seen in most of our experiments is probably to be explained on this basis.


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# The Zone of Localization of Anti-Mouse-Kidney Serum as Determined by Radioautographs[1]

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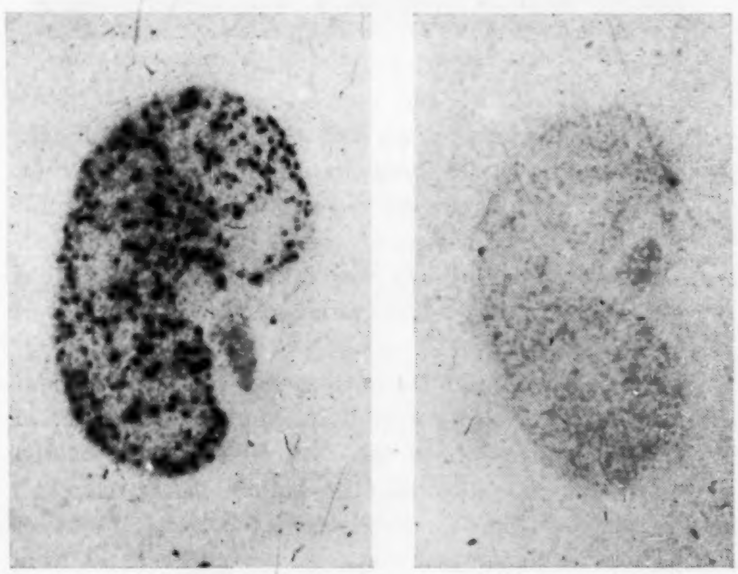
It has been shown previously by Pressman and Keighley (*4*) that antiserum prepared against rat kidney actually localizes in the kidney after intravenous injection into a rat. This was accomplished by iodinating the globulin fraction of anti-rat-kidney serum, prepared according to the method of Smadel (*5*), with iodine containing tracer amounts of $I^{131}$ and following the localization of the radioactivity in the kidney of the rat inoculated with this preparation. Similar results with mice have since been obtained with antiserum prepared against mouse-kidney tissue (*3*). By using iodine with a sufficient admixture of $I^{131}$, it has been possible for us to obtain radioautographs of the kidney tissue of mice injected intravenously with the radioiodinated globulin fraction of anti-mouse-kidney serum, and thus to determine more precisely the region of localization within the kidney.

In the experiment reported here, two mice were injected intravenously with the radioiodinated globulin fraction of anti-mouse-kidney serum prepared similarly to the radioiodinated globulin fraction of anti-rat-kidney serum described previously (*4*). Two control mice were injected with the radioiodinated globulin fraction of anti-mouse-plasma serum, prepared similarly, using the serum from rabbits which had been injected with mouse plasma. Such serum does not localize in the kidney as does the anti-mouse-kidney serum. Each mouse injected with the antikidney preparation received 0.3 ml of solution containing 3.3 mg of protein combined with 17 μc of radioiodine and, in the case of the mice injected with the anti-plasma fraction, 4.8 mg of protein, combined with 13 μc of radioiodine in 0.3 ml of solution, was used. Five days after the injection the animals were sacrificed. A blood sample was obtained before death from the dorsal aorta, and then the kidneys, spleen, and liver were removed without perfusion. One kidney, one half of the liver and spleen, and all the blood were used in the preparation of samples for the determination of the radioactivity content of the tissue. The results are given in Table 1. The other kidney and the rest of the spleen and the liver were fixed in 10% formalin and subsequently sectioned. Sections 10-μ thick and the blocks remaining after several sections had been cut were used in the preparation of radioautographs. The blocks were set up on Eastman Kodak medium lantern slides, while the sections were set up on Ansco No Screen X-ray film, according to the method described by Marinelli and Hill (*2*).

TABLE 1

RADIOACTIVITY OF TISSUES OF MICE INOCULATED WITH RADIOANTISERA 5 DAYS AFTER INOCULATION

| | Antiserum used | |
|---|---|---|
| | Antikidney serum | Antiplasma serum |
| Protein inoculated (mg) .... | 3.3 | 4.8 |
| Radioiodine on protein at the time of injection (μc) ..... | 17 | 13 |
| Tissue | Activity of tissue (μc/gram, 5 days after inoculation) | |
| Kidney .................... | 0.25 | 0.08 |
| Liver ...................... | .08 | .06 |
| Spleen ..................... | .16 | .13 |
| Blood ...................... | .27 | .21 |



A B

FIG. 1. Radioautographs of blocks of kidney tissue. A—from mouse injected with radioanti-mouse-kidney serum; B—from mouse injected with radioanti-mouse-plasma serum.

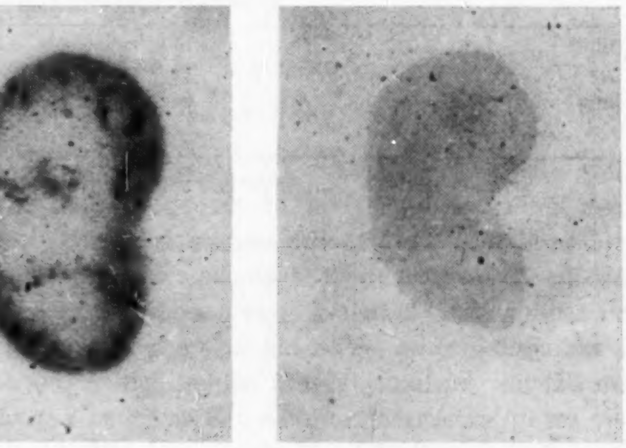
Fig. 1 shows the radioautographs of the kidney tissue blocks. The kidney from the mouse receiving the radioantikidney serum showed a definite accumulation of radioactivity around the cortex[3] (Fig. 1A) while the kid-

[1] This research was aided by grants from the Office of Naval Research and the American Cancer Society.

[2] Senior Fellow in Cancer Research, American Cancer Society Fellowship recommended by the Committee on Growth of the National Research Council.

[3] This is in accordance with the results of Heymann and Lund (*Science*, 1948, **108**, 448), who found that nephrotoxic antisera are produced from the cortical rather than the medullary kidney tissue.

ney from the mouse receiving the radioantiplasma serum showed no such accumulation (Fig. 1B). No accumulation was observed with either the liver or the spleen of the animals receiving the antikidney serum or the antiplasma serum. Fig. 2 shows the radioautographs of the kidney sections. In the sections from the animal receiving the radioantikidney serum there was a punctate accumulation of the radioactivity (Fig. 2A), while this was not the case for the kidney of the mouse receiving the radioantiplasma serum (Fig. 2B). Also, there was no such accumulation of radioactivity in the spleens or livers of the animals receiving either radioantikidney or radioantiplasma serum. With these tissues, very faint and diffuse radioautographs were obtained due to the radioactivity content of the blood in the organ.



A B

FIG. 2. Radioautographs of sections of kidney tissue. A—from mouse injected with radioanti-mouse-kidney serum; B—from mouse injected with radioanti-mouse-plasma serum.

Upon comparing the microphotograph of the kidney from the animals receiving the radioantikidney serum with an enlargement of the radioautograph, it was quite clear that the localization of the radioactivity and presumably the radioantibody was taking place in the glomeruli of the kidney. This point will be discussed more fully elsewhere (*3*).

The concentration of the antikidney serum in the glomeruli is not due to a nonspecific pickup by the kidney of foreign substances or to the fact that the radioactive material may pass through the kidney in its excretory path. The evidence for this is the fact that the radioantiplasma serum control contains substances of the same nature as radioantikidney serum, except for the specific kidney antibodies, and does not show any localization in the kidney. Similarly negative results were shown by a radioantiovalbumin serum. The radioactivity concentration in the various tissues for the two sera described here were quite similar except in the case of the kidney (Table 1). There the concentration of the radioactivity in the kidney of the animal receiving the radioantikidney serum was about three times that in the kidney of the animal receiving the control serum. The radioactivity in the kidney of the mouse receiving the control serum was essentially all due to the blood in the kidney, since mouse kidneys contain about 30–35% blood (*1*). The greater amount of radioactivity in the kidneys of the animal which received the antikidney serum must have been due to the kidney antibodies.

The localization of $I^{131}$ in the glomeruli as shown by the radioautographs is probably a result of the corresponding localization of the specific antibodies to glomerular tissue.

These experiments were repeated with other preparations of radioantikidney serum with similar results.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# Growth of Potato Sprouts Retarded by 2,4,5-Trichlorophenoxyacetic Acid[1]


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Guthrie (*1*) first discovered that methyl ester of α-naphthalene acetic acid, when applied to potato tubers, retards the growth of sprouts. Many potato growers are now using this chemical on a commercial scale to prevent sprouting of potatoes in storage. Smith, Baeza, and Ellison (*2*) found during the 1945 season that this chemical also retards sprout growth of potatoes in subsequent storage when it is applied as a spray to the potato plants during the growing season. During the 1946 season the authors found that two spray applications of 2,4,5-trichlorophenoxyacetic acid (2,4,5-T), 25 ppm on July 19 and 50 ppm on August 20, retarded subsequent sprout growth of potatoes to the same degree as two applications of methyl ester of naphthalene acetic acid (MENA), 2,000 ppm on July 19 and 2,000 ppm on August 20.

In the spring of 1947 tubers of the Sebago variety were treated separately with MENA and 2,4,5-T in isopropyl alcohol and water and applied as a spray at the rate of 1 gm of chemical/bushel of potatoes. Although both chemicals significantly retarded sprout growth as compared with untreated tubers, sprouts of those treated with MENA had significantly less weight than those of tubers treated with 2,4,5-T.

During the 1947 growing season spray applications of sodium naphthalene acetate (sodium NA), 500, 1,750, and 3,000 ppm, compared with applications of sodium 2,4,5-T at 50, 175, and 300 ppm, were made to plants of the Sebago variety. The effect on sprout growth during subsequent storage at 50° F from October 25 to February 26 is shown in Table 1.

In all cases sodium 2,4,5-T retarded sprout growth to a greater degree than sodium NA, although the latter was applied in concentrations 10 times the former. There

[1] Paper No. 301, Department of Vegetable Crops, Cornell University.

were no significant differences in yields of potatoes between any of the treatments.

TABLE 1

WEIGHT OF SPROUTS PER TUBER
(Concentration of spray in ppm)

| Date of application | Sodium NA 500 | Sodium 2,4,5-T 50 | Sodium NA 1,750 | Sodium 2,4,5-T 175 | Sodium NA 3,000 | Sodium 2,4,5-T 300 | Sodium NA Mean | Sodium 2,4,5-T Mean |
|---|---|---|---|---|---|---|---|---|
| | (gm) | (gm) | (gm) | (gm) | (gm) | (gm) | (gm) | (gm) |
| Aug. 1 | 2.30 | 1.70 | 2.27 | 1.22 | 2.27 | 0.87 | 2.28 | 1.26 |
| Aug. 22 | 3.07 | 2.93 | 2.82 | 2.25 | 3.13 | 1.97 | 3.01 | 2.38 |
| Sept. 10 | 3.22 | 2.73 | 3.13 | 2.75 | 3.10 | 2.83 | 3.15 | 2.77 |
| Means | 2.86 | 2.45 | 2.74 | 2.07 | 2.83 | 1.89 | 2.81 | 2.14 |
| Untreated: | | 3.17 gm | | | | | | |

Sodium NA not significantly different from untreated at 19 : 1.
Sodium 2,4,5-T significantly lower than sodium NA or untreated at 99 : 1.

During the spring of 1948 potato tubers of the Houma variety were treated in open baskets in storage with dust forms of MENA (1 gm/bushel) and isopropyl ester of 2,4,5-T (0.9 gm/bushel). Both treatments significantly reduced the weight of sprouts produced; treatment with MENA, however, resulted in greater retardation than treatment with isopropyl ester of 2,4,5-T.

It was assumed that one of the reasons for less retardation of sprout growth by isopropyl ester of 2,4,5-T compared with MENA was due to lesser volatility of the former. During the storage season early in 1948 potato tubers were treated with the chemicals in dust form indicated in Table 2 and stored at 50° F for 10 weeks in closed paper bags to confine the volatile sprout retardant in the atmosphere immediately around the tubers.

TABLE 2

EFFECT OF TREATING POTATO TUBERS WITH SPROUT RETARDANTS

| Treatment | Wt. of sprouts (gm/tuber) |
|---|---|
| 1.0 gm of isopropyl ester 2,4,5-T/bushel | 2.91* |
| 0.5 " " " " " " | 3.70* |
| 1.0 " " MENA " " | 1.46† |
| Untreated | 10.81 |

* Significantly lower than untreated lots at odds 99 : 1.
† Significantly lower than any other treatment at odds 99 : 1.

To obtain information on the penetrability of 2,4,5-T into tubers and its subsequent reaction on sprout growth, the following experiment was conducted. Ten toothpicks soaked for one week in saturated solution of sodium 2,4,5-T were inserted about 1″ into each tuber. After storage for three months at 50° F, treated tubers were just beginning to sprout, whereas several sprouts 3″ to 4″ long developed on each of the untreated tubers (Fig. 1).

The toothpick technique was further employed to insure equal penetration of sodium NA and sodium 2,4,5-T into comparable sets of tubers. Aqueous solutions of 1,000 ppm of the two respective salts were used for soaking the toothpicks. One set of toothpicks was soaked in distilled water for comparison. After the picks were soaked 5 days they were inserted into Houma tubers of similar size and one series of untreated tubers (no toothpicks) was included as a control. Eight replications

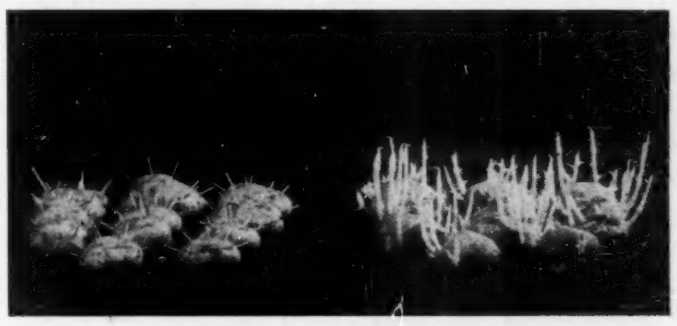

FIG. 1. Left: Tubers pierced with toothpicks which had been soaked in a saturated solution of sodium 2,4,5-T (10 toothpicks/tuber). Right: Untreated control tubers.

were used. Table 3 shows the effect of the above treatments on number and weight of sprouts. Single tuber plots were used and each value is the mean for 8 tubers.

TABLE 3

| Treatments | No. of sprouts/ tuber | Wt. of sprouts/ tuber |
|---|---|---|
| Toothpicks soaked in sodium NA (1,000 ppm) | 3.0 | 2.96 |
| Toothpicks soaked in sodium 2,4,5-T (1,000 ppm) | 5.0 | 2.61 |
| Toothpicks soaked in distilled water | 12.1 | 9.24 |
| Untreated control (no toothpicks) | 11.4 | 10.98 |

No significant difference was found between the sprout growth of tubers with distilled water-treated toothpicks and tubers with no toothpicks. Sprouting was reduced very significantly by both sodium NA and sodium 2,4,5-T, but no significant difference was found between the two in their effect on number or weight of sprouts. Further work is being conducted with other more volatile forms

of 2,4,5-T to determine its practical value as a sprout retardant on a commercial scale.


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## A New Dietary Factor Related to Xanthine Oxidase[1]


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Measurements of the xanthine oxidase activity in rat livers by the method of Axelrod and Elvehjem (*1*) have demonstrated that, in order to obtain normal liver xanthine oxidase levels on diets containing adequate riboflavin, two other dietary factors are essential. These are: (1) adequate protein, as originally indicated by McQuarrie and Venosa (*5*), and (*2*) an unidentified factor found in raw cream and liver, both good sources of xanthine oxidase.

Rats are born without any detectable xanthine oxidase activity in the liver, even when their mothers are on an adequate diet and have normal levels of xanthine oxidase in their own livers at the time of birth. Small amounts appear in the liver during the nursing period, and when the rats are weaned at 21 days of age, the average activity is 720 units ($C_{mm}O_2$/gm of dry liver/hr). This is less than half of the 1,550 units of activity found as an average for mature rats maintained on an adequate diet. If such weanling rats are placed on a diet containing 21% purified casein or 8% casein plus 13% peanut protein or 21% egg albumin plus biotin, the liver xanthine oxidase remains at approximately the starting level for 6 weeks. The 21% casein diet is given in Table 1; all other diets mentioned are identical except for the specific differences noted. When weanling rats are fed Purina dog chow (21% protein), the liver xanthine oxidase is brought to a normal level of 1,535 units in two weeks. If the Wesson oil and Crisco in the 21% purified casein diet are replaced by an equal amount of raw cream (6%), the liver xanthine oxidase activity of weanling rats is increased to 1,300 units in two weeks. If 5% dried whole liver replaces an equal weight of casein in the diet, the liver xanthine oxidase remains low for two weeks but is increased significantly after four weeks. Similarly, feeding a 21% crude casein diet does not affect the liver xanthine oxidase activity within two weeks, but gives levels of 1,260 units after four weeks.

TABLE 1

| | |
|---|---|
| Casein (GBI Vit. Test) | 21% |
| Crisco | 4 |
| Wesson oil | 2 |
| Cod-liver oil | 1 |
| Salt mix (Phillips and Hart) | 4 |
| Glucose | 68 |
| Choline chloride | 100 mg% |
| Nicotinic acid | 2.5 |
| Ca pantothenate | 1.0 |
| Riboflavin | 0.4 |
| Thiamine | 0.4 |
| Pyridoxine | 0.4 |

These experiments demonstrate that a 21% protein diet is adequate in providing the necessary protein for normal xanthine oxidase levels in the liver if another dietary essential is also incorporated in the diet in adequate amounts. In the relative absence of this unknown factor the starting levels of liver xanthine oxidase remain unchanged. When limited amounts of the factor are supplied, as with the liver and crude casein diets, the xanthine oxidase activity remains low for a period of time and then increases rather suddenly. Feeding a relative abundance of the factor, as with Purina dog chow and, to a lesser extent, the raw cream diet, gives a rapid increase to normal levels.

Rats fed an 8% casein diet (81% glucose) have essentially no xanthine oxidase activity in the liver after four weeks whether they were started as weanlings or were first brought to normal levels of activity by being fed Purina dog chow for two weeks. Rats brought to a zero level of xanthine oxidase activity by feeding them an 8% casein diet remain at the zero level when 6% raw cream replaces the Crisco and Wesson oil in the low-protein diet. Hence, supplying the dietary factor found in raw cream is ineffective in the absence of an adequate protein intake. Such zero levels of xanthine oxidase activity can be restored to normal by feeding dog chow; feeding the 21% purified casein diet allows a slower increase in the activity, indicating the presence of some of the unidentified factor in the diet containing purified casein.

The above experiments were carried out with animals obtained from Albino Farms. Sprague-Dawley rats have a lower xanthine oxidase level in the liver at weaning, averaging 430 units. They show considerably less individual variation at this time, but require appreciably longer dietary periods to bring the activity in the liver to normal levels.

Supplementing the 21% purified casein diet with biotin, inositol, *p*-aminobenzoic acid, pteroylglutamic acid, rutin, ergostanyl acetate, adenine, *d*-ribose, and additional riboflavin did not give normal xanthine oxidase levels in the liver. It is suggested that this dietary factor necessary for normal liver xanthine oxidase activity may be related to the unidentified component of the prosthetic group of xanthine and aldehyde oxidases (*2, 3, 4*).


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3. CORRAN, H. S., DEWAN, J. G., GORDON, A. H., and GREEN, D. E. *Biochem, J.*, 1939, **33**, 1694.
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[1] Supported by a grant from the Nutrition Foundation, Inc.

# Comments and Communications

## The Miticidal Properties of Di (*p*-Chlorophenyl) Methyl Carbinol in Laboratory Insect Rearings

Controlling mites in cultures of insects has long been a problem in many laboratories. The use of the chemical di (*p*-chlorophenyl) methyl carbinol appears to offer a solution to this problem.

The highly specific miticidal action of di (*p*-chlorophenyl) methyl carbinol has proved useful in this laboratory for the control of species of mites, presumably *Tyroglyphus* and *Pediculoides* spp., infesting insect cultures. A dust, 2 per cent by weight, was prepared, using the technical product (supplied by The Sherwin-Williams Co., Agricultural Chemicals Division) and pyrophyllite. This preparation has completely eliminated mites infesting cultures of the pomace fly (*Drosophila melanogaster*), the webbing clothes moth (*Tineola bisselliella*), the confused flour beetle (*Tribolium confusum*), the American roach (*Periplaneta americana*), and the rice weevil (*Sitophilus oryza*) without producing any observable mortality in the egg, immature, or adult stages of these insects. In addition, the following insects have been completely covered with the dust without any deleterious effects: black carpet beetle larvae (*Attagenus piceus*), grouse locusts (*Tettigidae*), and the large milkweed bug (*Oncopeltus faciatus*).

Best results have been obtained by generously applying the dust to the insect itself, sprinkling upon the surface of the culture media, or by mixing the dust intimately with the culture media.

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## Is There Laterite in Rocks of the Dakota Group?

During an inspection trip in Gage County Soil Conservation District, Nebraska, in 1943, the senior author noted the close similarity of certain beds of the Dakota group to the laterite of Buchanan. The material is a hard, cellular, slaglike "ironstone," ranging in color from red to yellowish brown and dark brown. In Gage County this material overlies reticulately mottled red and light-gray kaolinite clay beds of the Dakota group and of kinds that occur at several different horizons within the Dakota of Cretaceous age.

In the spring of 1948, C. G. Stephens, head of the Soil Survey of Australia, who was shown several outcrops in Saline and Ellsworth counties, Kansas, stated that some of the ironstone was closely similar to the "fossil laterites" of Australia, and that the mottled kaolinite clay beneath was also a typical companion material. Recently the authors have reviewed some of the literature on the Dakota formation, have studied many outcrops in Nebraska and Kansas, and have reached the following tentative conclusions: (1) that the Dakota group includes more than one horizon that contains material essentially like the laterite first described by Buchanan in India; (2) that this material probably represents a former subsoil horizon of an ancient soil; (3) that these ancient soils presumably were essentially like Marbut's groundwater laterite soils, described in the Amazon Valley, and were formed during periods when subsoil water fluctuated seasonally up and down in what is now a cellular ironstone.

Ground-water laterite soils occur most extensively, at present, under tropical climates with fluctuating, high water table or with periodic seepage. Climates with alternating wet and dry seasons are especially favorable to the formation of ground-water laterite soils, with their subsoil horizons of laterite. Present knowledge suggests that a long time is required for the formation of these soils.

According to various authors, the plant fossils of the Dakota group include persimmon, walnut, tulip tree, fig, laurel, sassafras, and others that suggest a somewhat warmer climate during the formation of the Dakota group beds of Nebraska and Kansas than the present one.

The writers have collected specimens and descriptions of laterite-like material and associated massive ironstones and kaolinitic clays from the Dakota group beds for further study. They expect to prepare a more detailed paper on the subject, and feel that a pedological interpretation will give a better understanding of the morphology and genesis of certain beds of the Dakota group than has been attained to date.

JAMES THORP and E. C. REED
*U. S. Department of Agriculture Division of Soil Survey, Lincoln, Nebraska,* and
*Conservation and Survey Division, University of Nebraska*

## On the Site of Discovery of the "Male Sterile" John Baer Tomato Mutant

In *Science* of May 14, 1948 (p. 506) the writer reported the finding of a new type of "self-sterility" applicable to hybrid tomato seed production. The site of find was not mentioned. This omission has had embarrassing consequences because a syndicated news rewrite of the article, rather excusably, implied the mutant was first observed at the West Tennessee Experiment Station. Actually it was first found, by the writer, in September 1945 while attending a field day at State College, Pennsylvania. It occurred as a single mutant rogue in a trial row of the variety John Baer growing in the horticultural plots at the Pennsylvania Agricultural Experiment Station. The plant was called to the attention of R. E. Larson, who kindly consented to share cuttings.

During the past year numerous requests for seed have come to the writer. To avoid possible duplication of effort by those interested in working with the plant, it is pointed out that this identical mutant has also been distributed by Dr. Larson.

W. E. ROEVER
*West Tennessee Experiment Station*

# Book Reviews

***Introduction to chemical thermodynamics.*** (2nd ed.) Luke E. Steiner. New York-London: McGraw-Hill, 1948. Pp. xiv + 510. $6.00.

This book has been prepared to introduce the subject of chemical thermodynamics, including the fundamental theory and application of the various useful thermodynamic functions to chemical systems. For this second edition a number of sections have been rewritten and new material has been added, including, particularly, expansion of the material on real gases and of the statistical calculation of thermodynamic functions. The author has made a strong effort to bring the text up to date from the standpoint of references to source data in the literature and to existing compilations on chemical thermodynamic properties. Those parts of the first edition, found through teaching experience to lack clarity or logic, have been rewritten. Latest values of the fundamental constants are used.

This book is recommended to those desiring an introduction to thermodynamics.

FREDERICK D. ROSSINI

*National Bureau of Standards*

***The recruitment, selection, and training of social scientists.*** (Bull. 58.) Elbridge Sibley. New York: Social Science Research Council, 1948. Pp. xv + 163.

To help orient the fellowship policies of the Social Science Research Council, in the face of the shortage of social scientists coincident with the expanding need for their services, Dr. Sibley undertook an analysis of the factors currently affecting the flow of personnel into the field. In his study, as is indicated in the title, problems of recruitment, selection, and training were given careful attention. The fourth component, employment outlook, was deliberately omitted on the assumption that with improvement in the other three aspects, competence, public recognition, and confidence will increase, and opportunities for professional employment will almost automatically improve.

The data utilized permit not only comparisons among the several social science disciplines but also cross-comparison with the natural sciences. Though this report interprets the data with respect to the conditions in the *social* sciences, those specializing in the natural sciences will find much to interest them.

The study of potential and actual recruits to the social sciences is comforting to the extent that it makes clear that not all the ablest members of the academic generation are being drawn away from the social sciences and that, man for man, the best social science graduate students are as bright as the best graduate students in the natural sciences. A warning note is sounded, however, by the larger proportion of those with apparently mediocre and inferior endowment in the social science group, as compared with the natural sciences. The pressure of the mediocre and inferior students apparently has had an undesirable effect on the quality of the training for the better-endowed undergraduate students majoring in the social sciences. The graduate departments in social science are, therefore, forced to begin their training at a level far lower than is done in other graduate science departments. In considering remedies, caution is indicated in the light of the large proportion of social science students who have no interest in careers as scientific researchers—the latter being the group with which Sibley has been most concerned in this study.

We cannot here review the full complement of the findings of this study or the variety of implications discussed. Anyone interested in the continued development of the social sciences should find this report worth reading. For those concerned with the training of future social scientists, it is a must.

EUGENE L. HARTLEY

*The City College of New York*

***A symposium on the use of isotopes in biology and medicine.*** Madison: Univ. of Wisconsin Press, 1948. Pp. ix + 445. $5.00.

The twenty papers included in this book were presented as a symposium at the University of Wisconsin in September 1947. Nineteen scientists contributed, all of whom are most competent in their specialties. The University of Wisconsin committee, which arranged the symposium, is to be congratulated on the quality of the contributors and on the choice and arrangement of topics.

Hans T. Clarke opens the symposium with a brief account of the history of isotopes in biochemistry. This is followed by a group of 3 papers dealing with ways of obtaining isotopes: the means of separating stable isotopes (Harold C. Urey); the methods of preparing the numerous radioactive ones (Glenn T. Seaborg); and the availability of both stable and radioactive isotopes, particularly those distributed by the Atomic Energy Commission (Paul C. Aebersold). Next follows a group of 3 papers on the assay of isotopes. Alfred O. Nier deals with the detection of stable isotopes, with special reference to the mass spectrometer; Charles D. Coryell reviews the principles of measurement of radioactivity; and Martin D. Kamen describes the application of these principles to the assay of radioisotopes in biological material, with special emphasis on tritium ($H^3$), short-lived carbon ($C^{11}$) and long-lived carbon ($C^{14}$). These authors are followed by Donald B. Melville, who presents important examples of the synthetic procedures used in incorporating tracer atoms into organic molecules.

After the foregoing groups of articles dealing with techniques, there follow 6 reviews of results obtained with tracers: in protein metabolism (David B. Sprinson); in intermediary carbohydrate metabolism (Harland G. Wood); in intermediary metabolism of lipids (Konrad

Bloch); in mineral metabolism (David M. Greenberg); in iodine metabolism and thyroid function (I. L. Chaikoff and A. Taurog); and in general medicine (Joseph G. Hamilton).

Therapeutic applications of radioisotopes are described in two papers by Byron E. Hall (radiophosphorus) and by Saul Hertz (radioactive iodine). Health hazards in the use of radioisotopes are discussed by William F. Bale, primarily from the standpoint of the physicist, and by James J. Nickson from the standpoint of the physician. The book ends with thought-provoking essays by Harold C. Urey, on international aspects of atomic energy, and by Farrington Daniels, on the development and applications of atomic energy.

The book in general is clearly written. Although it was lithoprinted in order to speed production, it is quite legible. Errors are few, and these are concisely listed on a single sheet. The illustrations include photographs of all the contributors and the chairmen of the various sessions.

Although various other works on isotopes in biology have been and are appearing, the authoritative nature of most of the contributions to this book make it a most useful addition to the library of the "isotopic" biologist, particularly if he is interested in tracers.

RAYMOND E. ZIRKLE

*University of Chicago*

***Chymia: annual studies in the history of chemistry.*** (Edgar F. Smith Memorial Collection: Univ. Pennsylvania, Vol. I.) Tenney L. Davis. (Ed.) Philadelphia: Univ. of Pennsylvania, 1948. Pp. xiv + 190. (Illustrated.) $3.50.

Situated at the University of Pennsylvania is one of the most important collections of rare books, prints, and manuscripts relating to the history of chemistry to be found anywhere in the United States. This collection was originally the private library of the late Edgar Fahs Smith, provost and historian of chemistry at the University. After his death in 1928, Mrs. Smith presented the library to the University, endowing it so that it might grow and flourish. This it has done, as several important collections have since been added to it, thereby enriching its resources.

With the recent publication of *Chymia*, one of Dr. Smith's dreams is brought to fruition, for he had wanted to establish a journal devoted to the history of the science with which his name was so long identified. As stated in the Introduction by Eva V. Armstrong, curator of the Smith Collection, "*Chymia* is intended to promote international scholarship in the history of chemistry, to bring a glimpse of the Edgar Fahs Smith Memorial Collection to those who would drop in for a visit some afternoon if it should be physically convenient to do so, and to provide a meeting ground for those who find pleasure in studies such as it reports." In spirit and in format this first volume of 13 articles admirably embodies the purposes expressed above.

The book opens appropriately enough with the last paper written by the late C. A. Browne (1870–1947), himself a distinguished historian of chemistry, whose library has very recently been added to the Collection. Browne's paper, "Recently acquired information concerning Fredrick Accum, 1769–1838," is a subject on which he had previously written. Claude K. Deischer follows with a memorial tribute to Dr. Browne and concludes with a bibliography of his writings on the history of chemistry—the list of 148 published and 17 unpublished papers speaks for itself. F. Sherwood Taylor transcribes and discusses an English alchemical poem, and Henry M. Leicester tells how Mendeleev promulgated the Periodic Law. Tenney L. Davis, well-known historian of pyrotechnics and editor of *Chymia*, provides an interesting account of the early use of potassium chlorate in the making of fireworks, and George Urdang, historian of pharmacy, writes learnedly and charmingly on the chemical and pharmaceutical history of calomel.

One of the most important contributions is a paper by Sidney M. Edelstein in which is published a hitherto unknown letter by Joseph Priestley. This appears to settle conclusively the famous controversy as to the parts played by Watt, Cavendish, Lavoisier, and Monge in discovering the chemical constituents of water.

It is evident that with this first volume of *Chymia* a new and important medium for the publication of studies in the history of chemistry and related sciences has appeared. May succeeding volumes continue on the high plane of scholarship and readability set by this first offering.

MORRIS C. LEIKIND

*Library of Congress, Washington, D.C.*

# *Scientific Book Register*

BARNETT, LINCOLN. *The universe and Dr. Einstein.* (With a foreword by Albert Einstein.) New York: William Sloane, 1948. Pp. 127. (Illustrated.) $2.50.

BREMEKAMP, C. E. B. *Notes on the Acanthaceae of Java.* (Nederl. Akad. Wet., Verh. (Tweede Sectie), Dl. XLV, No. 2.) Amsterdam: N. V. Noord-Hollandsche Uitgevers Maatschappij, 1948. Pp. 78.

GODDARD, ROBERT H. (GODDARD, ESTHER C., and PENDRAY, G. EDWARD, Eds.). *Rocket development: liquid-fuel research 1929–1941.* New York: Prentice-Hall, 1948. Pp. xx + 291. (Illustrated.) $6.50.

JOHNSTON, H. F., *et al. Magnetic results from Huancayo Observatory, Peru, 1922–1935* and *Magnetic results from Huancayo Observatory, Peru, 1936–1944.* (Vols. X-A and X-B, respectively.) Washington, D. C.: Carnegie Institution, 1948. Vol. X-A: Pp. vi + 609. (Illustrated.) $3.25, paper; $3.75, cloth; Vol. X-B: Pp. v + 385. $2.00, paper; $2.50, cloth.

SNYDER, H. R. (Ed.-in-Chief.) *Organic syntheses.* (Vol. 28.) New York: John Wiley; London: Chapman & Hall, 1948. Pp. vi + 121. (Illustrated.) $2.50.

# NEWS and Notes

**Beno Gutenberg,** professor of geophysics and director of the California Institute of Technology Seismological Laboratory, and **Charles F. Richter,** associate professor of seismology, will attend the 7th Pacific Science Congress being held in New Zealand early in February. Both Dr. Gutenberg and Dr. Richter will present papers on special problems in seismology as related to the Pacific area.

**Robert H. Cole,** associate professor of chemistry, Brown University, will become the new department chairman July 1, following the resignation of **Paul C. Cross.** At that time Prof. Cross will assume his new duties as head of the Chemistry and Chemical Engineering Department at the University of Washington. **Donald F. Hornig,** assistant professor of chemistry at Brown, will become director of its Metcalf Research Laboratory.

**Roger L. Geer** of the College of Engineering at Cornell University has been appointed national chairman of the Committee on Inspection and Gaging for the Instrument Society of America. Prof. Geer, who initiated the first formal instruction in precision measurement at Cornell, supervises the Gage Laboratory which is being developed to include equipment for instruction and service to that area.

**Frederick Wyatt** was recently appointed chief psychologist at Cushing Veterans Administration Hospital, Framingham, Massachusetts. Dr. Wyatt will continue in his capacity as associate professor in the Clark University Department of Psychology.

**Gerhard Herzberg** and **Leslie E. Howlett,** of the National Research Council of Canada, became, respectively, director and associate director of the Division of Physics, effective January 1. Dr. Herzberg, former professor of spectroscopy at the Unversity of Chicago, had been acting as a principal research officer. In his new position he succeeds **R. W. Boyle,** who retired last October. Dr. Howlett has been in charge of optics on the NRC staff since 1931.

**M. H. Harnly,** of Washington Square College, New York University, will address the Section of Biology of the New York Academy of Sciences February 14 at 8 P. M. on the subject "A Morphological Interpretation of the Effect of Temperature Upon Development."

**Clarence E. Davies,** executive secretary of the American Society of Mechanical Engineers, was recently appointed a term trustee of Rensselaer Polytechnic Institute.

**Wallace Richards,** formerly assistant director of the Carnegie Museum, Pittsburgh, Pennsylvania, assumed the duties of director January 1, upon the retirement of **O. E. Jennings.** Dr. Jennings has been made director emeritus of the Museum.

**Lawrence H. Gahagan,** of New York City, has been appointed consulting psychiatrist in the Department of Health and Hygiene, Vassar College. Dr. Gahagan was at one time an assistant professor of psychology at the University of California, Los Angeles.

## Visitors to U. S.

**J. C. Saha,** of the Department of Botany and Mycology, Presidency College, Calcutta, India, who has until recently been acting as visiting research fellow in forest pathology at Yale University is now en route to India, making visits to English and French institutions on the way. During the past two years Dr. Saha has been visiting various U. S. and Canadian universities and state agricultural experiment stations, completing his Ph.D. requirements at West Virginia University.

**Leslie Paul Greenhill,** chief technician of the Visual Aids Centre, University of Melbourne, was recently appointed research assistant on the staff of the Instructional Film Research Program at Pennsylvania State College. Mr. Greenhill recently arrived from England where he spent a year in study of the production and utilization of instructional films and, while there, represented Pennsylvania State College at the second annual Congress of the International Scientific Film Association.

**Rudolf Florin,** director of the Botanical Garden, Stockholm, Sweden, (*Science*, Oct. 15, p. 406), has been presenting a seminar series at the University of California, Berkeley, on the nature of the female reproductive organs in fossil Cordaites, Coniferales, and Taxads. Before arriving on the West Coast, Dr. Florin had given the Prather Lectures at Harvard.

## Grants and Awards

**National Cancer Institute** grants totalling $1,319,483, have been announced by the Federal Security Administrator, Oscar R. Ewing, following recommendations of the National Advisory Cancer Council. These grants which have been approved by Leonard B. Scheele, Surgeon General of the Public Health Service, will aid in laboratory and clinical cancer research, cancer control projects, and cancer teaching in medical and dental schools.

Of the 50 grants approved for laboratory and clinical research in 15 states, the District of Columbia, and three foreign countries, 18 are new and 32 continuous. The research projects include investigations of possible therapeutic agents; metabolism studies of cancer, using such techniques as tracing by radioactive isotopes; physiologic and pathologic investigations of stomach cancer; studies on the production of cancer in experimental animals, with emphasis on the determination of possible causative agents; and comparative examinations of tissues and sera in normal and malignant states. The 11 grants for cancer control went to nonfederal institutions and agencies to support studies of cancer diagnostic tests, environmental cancer, tumor pathology, cancer teaching methods, and other special control projects. Grants to continue cancer teaching of undergraduates went to 23 medical schools and 9 dental schools.

**The first Philip A. Benson Fellowship Award** for medical research has been announced by J. A. Curran, president of the Long Island College of Medicine. The award commemorates the late Philip A. Benson, former president of the Dime Savings Bank

of Brooklyn. The recipient of the fellowship is Irving Rappaport, instructor at the College, who has had training and experience as a malariologist and parasitologist in tropical medicine in Australia, New Guinea, and the Philippines.

**The West Virginia Agricultural Experiment Station** has received a grant of $4,000 for the year 1949 by Swift and Company, Chicago, for continuation of Burch H. Schneider's studies on the digestibility and composition of feeding stuffs by farm animals.

**Morris S. Kharasch,** Carl William Eisendrath Professor of Chemistry at the University of Chicago, has been selected to receive a John Scott Award in recognition of his outstanding work in the field of alkyl mercurials. Dr. Kharasch first suggested the use of such compounds as ethyl mercury chloride as seed disinfectants and developed improved reactions for their synthesis, leading to greatly increased yields of cotton, corn, wheat, and other crops. The award, consisting of $1,000 and a copper medal, will be presented to Dr. Kharasch at a dinner of the Delaware Section of the American Chemical Society at the Hotel du Pont, Wilmington, Delaware, on Wednesday, January 26.

## Fellowships

**Bryn Mawr College** announces the availability of the following fellowships and scholarship awards in sciences in its Graduate School for 1949–50: Department of Geology—one resident fellowship ($1,250), one or two resident scholarships ($650), two demonstratorships ($1,000); Department of Chemistry—one resident fellowship ($1,250), one or two resident scholarships ($650), several demonstratorships ($1,000); Department of Physics—one or two resident scholarships ($650), one or more research assistantships ($750–$1,000), two demonstratorships $1,000); Department of Mathematics—one resident fellowship ($1,250), one or two resident scholarships ($650), readership ($700); Department of Psychology—one resident fellowship ($1,250), one or two resident scholarships ($650), one demonstratorship ($1,000); Department of Biology—one resident fellowship ($1,250), one or two resident scholarships ($650), two half-time demonstratorships ($1,000 each). Three scholarships ($700) are offered to qualified students who wish to continue study in fields such as biochemistry, biophysics, crystallography, geochemistry, geophysics and psychophysics and two fellowships ($1,250) to candidates in the same fields.

Applications should be in before *March 1.* Full information and blanks may be obtained by writing to the Office of the Dean of the Graduate School, Bryn Mawr College, Bryn Mawr, Pennsylvania.

**Armour Research Foundation of Illinois Institute of Technology** has announced the availability of several industrial research fellowships starting September 1949, in the fields of physics, chemistry, chemical, mechanical and electrical engineering, metallurgy, ceramics, and applied solid and fluid mechanics. During the school terms half-time graduate study will be provided, tuition free, in the Graduate School of Illinois Institute of Technology concurrently with half-time research employment in Armour Research Foundation (and full-time employment in the intervening summer), equivalent to a total stipend of about $3,750. Appointments will be announced *March 15,* 1949, prior to which time information and application blanks may be obtained from the Dean of the Graduate School, Illinois Institute of Technology, Technology Center, Chicago 16.

## Colleges and Universities

**The physiological and psychological effects of arctic** temperatures will be studied by a group of University of Washington scientists for the next two years. Operatng under a contract from the Air Surgeon's Office of the USAF, an expedition left for Alaska on January 15 to establish headquarters at the Arctic Aeromedical Laboratory at Ladd Field, Fairbanks. Investigations for the project, which is being directed by Loren D. Carlson, of the Department of Physiology and Biophysics, will be conducted by three research teams. One, composed of physiologists, electronics engineers, mechanical engineers, physicists, and chemists, will study the effects of arctic temperature on the body; another will be concerned with fatigue, performance, and mental phases of the problem; and the third will study arctic animals to learn if factors of animal survival can be applied to humans.

**North Carolina State College** has announced plans for the construction of a $1,245,000 Engineering Laboratories Building. Equipped with the latest devices for instruction, research and industrial service, the building will contain X-ray equipment, high-voltage electrical apparatus, and complete ceramic and structural clay investigation machinery. J. H. Lampe, dean of the School of Engineering, estimates that it will be completed not later than June, 1950 and will be one of the most modern structures of its type in the country.

**The Daniel and Florence Guggenheim Jet Propulsion Centers** will be established at Princeton University and the California Institute of Technology to provide facilities for post-graduate education and research in jet propulsion and rocket engineering. The two centers have been underwritten by the Daniel and Florence Guggenheim Foundation for seven years with an appropriation of $500,000, to be used to pay salaries of professors, fellowships of graduate students, and similar expenses. Buildings and equipment will be provided by the universities. The principal post in each center will be a Robert H. Goddard professorship, named for the late Robert H. Goddard, of Clark University. Caltech's Goddard professor will be Dr. Hsue-Shen Tsien, 38-year old native of China, now professor of aerodynamics at MIT.

**A study of the problems of growth and differentiation** by critical discussion has been undertaken by research workers at Amherst, Mt. Holyoke, and Smith Colleges, and the University of Massachusetts. The members are: Virginia C. Dewey, Taylor Hinton, George W. Kidder, Robert E. Parks, Jr., Harold H. Plough, and Oscar E. Schotté, of Amherst College; A. Elizabeth Adams and Christianna Smith, of Mt. Hol-

yoke College; Albert F. Blakeslee, Jacob Rappaport, S. Meryl Rose, and Sophie Satin, of Smith College; and David W. Bishop and Gilbert L. Woodside, of the University of Massachusetts.

## Industrial Laboratories

**Per K. Frolich,** director of research and Development for Merck & Company, Inc., has been appointed vice-president for Research and Development, to succeed **Randolph T. Major,** who will continue as director of all scientific activities of the Company.

**Eastman Kodak Company** has announced the availability of nitrogen 15 in the form of either nitric acid or potassium nitrate. The company has been supplying $N^{15}$ in the form of ammonium salts and as potassium phthalamide in concentrations up to 60 atom per cent $N^{15}$. The ammonium nitrate has $N^{15}$ in the ammonium radical only. The nitric acid will be supplied as an aqueous solution containing at least two moles per liter; the potassium nitrate is available as a dry solid.

**The Polytechnic Research and Development Company, Inc.,** formerly located at 66 Court Street, Brooklyn, New York, announces the opening of new and expanded research laboratories at 202 Tillary Street, Brooklyn, New York. The concern is headed by H. S. Rogers, president of the Polytechnic Institute of Brooklyn, and is under the technical direction of F. J. Gaffney.

**Studies of cosmic rays and nuclear forces** will be furthered by the new 16-bev bevatron, for which the electrical equipment is now being built by the Westinghouse Electric Corporation, with funds provided by the Atomic Energy Commission under its pure research program. The new machine, to be installed on the Berkeley campus of the University of California, will be 17 times more powerful than the University's present cyclotron. The electrical equipment will consist of two alternating-current motor-generator sets, each capable of developing 50,000 kilowatts; Ignitrons to change alternating into direct current electrically; and a network of controls and meters to channel the power into a 10,000-ton circular steel magnet.

**Pyridium Corporation,** of Nepera Park, New York, announces the appointment of **Roland G. Benner** as director of Development and Engineering. For the past 19 years Mr. Benner had been associated with E. I. du Pont & Company of Wilmington, Delaware, in various capacities, his most recent being in charge of the Applied Process Control Group.

## Meetings and Elections

**The Spectroscopy Society of Pittsburgh** is sponsoring the 9th Pittsburgh Conference on Applied Spectroscopy on February 18 and 19 at Mellon Institute Auditorium, Pittsburgh, Pennsylvania. The Chairman for absorption spectroscopy papers is Joseph Lieblich, Mellon Institute; for emission spectroscopy papers, Joseph Geffner, Weirton, West Virginia.

**Plans for the 30th Annual Meeting of the American Geophysical Union,** April 20–22, 1949, Washington, D. C., provide for sessions for all Sections, as well as a general session and joint sessions of two or more Sections. Papers are invited for the Sections on Geodesy, Seismology, Meteorology, Terrestrial Magnetism and Electricity, Oceanography, Volcanology, Hydrology and Tectonophysics. Further information regarding submission of titles and abstracts may be obtained from the office of the American Geophysical Union at 1530 P Street, N.W., Washington, D. C. Comments relating to papers and symposia bearing on more than one Section will be welcomed. They should be addressed to J. P. Marble, Chairman of the Committee on Meetings, U. S. National Museum, Washington 25, D. C. Members planning to attend the meetings are urged to make their hotel reservations promptly directly with the hotel as the Committee has no facilities for handling these.

Regional meetings have been planned for these dates: February 4–5, Los Angeles; April 26–27, Denver.

**The 1st International Congress of Biochemistry** will be held in Cambridge, England, August 19–25. Officially recognized by the International Union of Chemistry, the Congress is an outgrowth of meetings of biochemists from many countries which the Société de Chimie Biologique has organized from time to time in the past. The success of these meetings indicated the desirability of a full international congress of biochemistry. In addition to the meetings of the 11 Sections of the Congress, there will be Congress lectures and visits to research stations and laboratories. Further details for those wishing to join the Congress may be secured from Lt. Col. Francis J. Griffin, Honorary Organiser, 56 Victoria Street, London, S.W. 1. Arrangements have been made to house a limited number of visitors in the colleges of university; however, early reservations are requested.

**The 2nd Inter-American Congress of Brucellosis** was held under the auspices of the Pan-American Sanitary Bureau at Mendoza and Buenos Aires, Argentina, November 17–26. The U. S. was officially represented by James H. Steele, Chief, Veterinary Public Health Division, Communicable Disease Center, U. S. Public Health Service, who was named chairman of the delegation, and C. K. Mingle, assistant chief, Tuberculosis and Brucellosis Eradication Division, Bureau of Animal Industry. The meeting at Mendoza was devoted to research and epidemiology papers, while that at Buenos Aires was mainly concerned with discussion of the diagnosis and therapy of human brucellosis.

Two permanent committees were created to study the problems of standardization of human serological diagnostic methods and animal disease eradication, the success of both depending upon having a standard antigen with which to compare others. It was believed that the antigen of the Bureau of Animal Industry, U. S. Department of Agriculture, would be the best standard to use as it is available in large quantities and could be readily distributed. Similar studies will be conducted on animal serology. The Congress agreed that the control of the disease in animals was the first step toward controlling it in humans.

The 2nd **Inter-American Congress on Brucellosis** voted to accept the invitation of the U. S. to hold the next Congress in Washington, D. C., in October 1950. William W. Spink, of Minneapolis, has been named chairman of the 3rd Inter-American Congress on Brucellosis and M. Ruiz Castaneda will continue as Secretary.

**James B. McNaught,** professor of pathology at the University of Colorado School of Medicine and head of the Department of Pathology at the Medical Center, was named president elect of the American Society of Clinical Pathologists at their annual scientific meeting in Chicago last October. Dr. McNaught will serve during 1949.

**The U. S. National Committee of the International Commission of Optics** (an affiliate of the International Union of Pure and Applied Physics), has been reconstituted and enlarged since its first formal meeting held at Delft, Holland, in July 1948. The present membership of the committee is: Stanley S. Ballard (chairman), Department of Physics, Tufts College; Irvine C. Gardner, National Bureau of Standards; Max Herzberger, Eastman Kodak Company; Herbert E. Ives, Bell Telephone Laboratories (retired); F. A. Jenkins, University of California, Berkeley; Deane B. Judd, National Bureau of Standards; Rudolf Kingslake, Eastman Kodak Company; George Wald, Harvard University; and Mary E. Warga, University of Pittsburgh.

**Rustin McIntosh,** Carpentier Professor of Pediatrics at the College of Physicians and Surgeons, Columbia University, was recently elected the 1949 chairman of the American Council on Rheumatic Fever of the American Heart Association.

The **Division of Colloid Chemistry,** American Chemical Society, recently elected the following new officers: Desiree S. Le Beau, director of research, Midwest Rubber Reclaiming Company, East St. Louis, chairman; Sydney Ross, of the Rensselaer Polytechnic Institute, chairman-elect; W. O. Milligan, Rice Institute, secretary-treasurer (re-election) and divisional representative on the Society's National Council; and Alfred J. Stamm, Forest Products Laboratory, USDA, Madison, Wisconsin, and John D. Ferry, University of Wisconsin, members of the Division's executive committee.

Dr. Le Beau, the first woman to head the Division, succeeds Robert D. Vold, of the University of Southern California, who was elected to the Division's Colloid Symposium Committee.

**The Twelfth Annual Tri-States Geological Conference** was held in northeastern Iowa on October 23 and 24. More than 250 geologists from Illinois, Wisconsin, and Iowa traveled the 150-mile conference route, which roughly followed the Mississippi River, from Lansing to Bellevue. Eleven stops were made to afford the participating geologists an opportunity to see the full geologic section from the upper part of the Cambrian Franconia formation to the Silurian Hopkinton formation. In addition, geomorphic, topographic, and other allied features were observed in this almost driftless, but not unglaciated, area. A guidebook containing geological discussions, well logs, maps, and stratigraphic sections, together with an annotated road log, was furnished each participant.

New members of the Executive Committee elected to represent their respective states for the next 3 years were: E. C. Dapples, succeeding J. Harlan Bretz for Illinois; F. T. Thwaites, succeeding L. M. Cline for Wisconsin; and C. H. Roy, succeeding H. Garland Hershey for Iowa. The 1949 conference will be held in Illinois under the chairmanship of Dr. Dapples.

## Deaths

**Brent S. Drane,** 67, consultant and deputy member of the Hydrology Panel, Research and Development Board, who had served as civil engineer in various state and federal government capacities, died November 22 at his Chapel Hill, North Carolina, home.

**Karl Bonhoeffer,** 80, former professor of psychiatry at Berlin University, died in Berlin, Germany December 4. Last May Dr. Bonhoeffer became an honorary member of the Amercan Psychiatric Association, the first German scientist to be so honored since World War II.

**Albert K. Epstein,** 58, consulting chemist and president of Emulsol Corporation, Chicago, died December 22 in Tel Aviv, Israel.

**Homer W. Hillyer,** 89, retired chemical engineer and former professor of organic chemistry at the University of Wisconsin, died in Farmington, Connecticut on January 3.

**Clyde Fisher,** 70, ex-chief curator of Hayden Planetarium and participant in expeditions to the Arctic Lapland, Siberia, Mexico and Peru, died in Doctors Hospital, New York City on January 7.

**C. K. Edmunds,** 72, president emeritus of Pomona College, was killed in an automobile accident in Claremont, California, on January 9. From 1903–24 Dr. Edmunds was professor of physics and electrical engineering at Canton Christian College, China, and later became provost of Johns Hopkins University.

**The origin of the Pacific atolls** is the subject of further study made possible by the loan by the British Museum to the U. S. National museum of two tons of rock specimens drilled from Funafuti Atoll. Cornell University reports that the specimens taken from an 1,100-foot boring on Ellice Island, put down by a joint expedition of the Royal Society of London and the Australian Government in 1896, will be compared with rock from deep borings made on Bikini Atoll following the atomic bomb tests in 1947 (see *Science*, January 16, 1948).

John W. Wells, of the Department of Geology of Cornell University, conducted the negotiations with the British Museum at the suggestion of Harry S. Ladd, of the Basic Sciences Section of the U. S. Geological Survey, who expressed the thought that improved instruments and new techniques for geological interpretation might produce new facts from specimens last examined 50 years ago. The studies will be made in Washington, D. C.,

where the Bikini material is housed, by members of the Geological Survey and geologists from Cornell and other cooperating institutions.

In 1839 Charles Darwin advanced the theory that the Pacific atolls are the vestiges of volcanic islands which have subsided into the sea. Study of Funafuti borings did not settle the matter and samples were stored in the British Museum, where they rested until shipped to Washington last November. Preliminary investigation indicates that the Bikini rock is sand-like in nature, quite different from the Funafuti material, and also different from the volcanic rock which Darwin had predicted. The two atolls are only 1,500 miles apart, but evidence seems to indicate that the Funafuti rock is not more than 25,000 years old and that from Bikini 10,000,000–15,000,000 years old.

**The U. S. Atomic Energy Commission** has adopted a formal personnel policy which exempts its positions from competitive Civil Service and establishes an independent merit system. Personnel will receive the same leave and retirement benefits as are now granted federal employees. The new policy succeeds a series of temporary arrangements in effect since January 1, 1947, when the AEC took over management of the national atomic energy program from the Manhattan Engineer District of the U. S. Army.

**A Book Coupon Scheme** was recently launched by UNESCO on a one-year experimental basis to enable educators, scientists and professional people in war-devastated countries to obtain needed periodicals, text and reference books on education, science and culture from other countries. In special ceremonies at Unesco House, $150,000 in coupons was initially delivered to representatives of the participating countries: Austria, China, Czechoslovakia, France, Greece, Hungary, India, Italy, Indonesia, Iran, the Philippines, Poland and the United Kingdom. The coupon scheme will enable groups in these countries to buy publications from so-called ''hard-currency'' countries like the United States, while making payments in their own national currency. In each participating country special Distributing Bodies have been appointed for the sale of book coupons and as information centers for questions relating to the program. The American Booksellers Association has been appointed to administer the UNESCO program in the United States.

**Methods of presenting atomic energy to high school students** were considered at the New England School Science Council Atomic Energy Workshop, held in Boston December 27–31. The workshop, under the direction of Fletcher G. Watson, chairman of the New England School Science Council, and sponsored by the Boston Museum of Science and the American Academy of Arts and Sciences, was composed of U. S. Atomic Energy Commission officials, nuclear scientists and 50 New England high-school science teachers. Among the USAEC officials who took part were Shields Warren, director, Division of Biology and Medicine; Morse Salisbury, director, Division of Public and Technical Information Service; and George Glasheen, assistant director in charge of Public Education in the Information Service. Scientists participating represented MIT, Harvard University, Arthur D. Little Company, and Brookhaven National Laboratory. Besides developing methods of teaching atomic energy in the New England schools, the workshop may serve as a model for other atomic energy workshops now being planned across the country.

## Make Plans for—

**American Geophysical Union,** 23rd regional meeting, February 4–5, University of California, Los Angeles.

**American Society of General Physiologists,** regional meeting, February 5, Washington Square, New York University, New York City.

**American Mathematical Society,** February 26, meetings in New York City and Chicago.

**5th International Congress for Comparative Pathology,** May 17–20, Istanbul, Turkey.

## Recently Received—

Centri-Die Castings. New booklet available on request from the Lebanon Steel Foundry, Lebanon, Pennsylvania.

Catolog No. 7 of Edwards Brothers, Inc., Ann Arbor, Michigan (listing of 700 foreign scientific and technical books and sets reproduced by license of the Office of Alien Property).

Immunity Bulletin, May 1946–April 1947. A synopsis of researches at the Bengal Immunity Laboratory, Calcutta, published by the joint secretaries, Immunity Scientific Association, 39 Lower Circular Road, Calcutta 16.

The story of soap. Illustrated pamphlet issued by the Procter & Gamble Company, Cincinnati, Ohio.

High school: what's in it for me? Prepared by the Office of Education and produced through courtesy of American Technical Society, Drexel at 58th Street, Chicago 37, Illinois, from which copies are available.

The Story of Norge. Illustrated pamphlet available through Borg-Warner Corporation, Detroit, Michigan.

Postgraduate education in high school 1947–48, by Homer Kempfer. (Pamphlet No. 106, Office of Education.) Washington, D. C.: U. S. Government Printing Office, 1948. $.10.

The animal protein factor, by Ruth Woods. In *Borden's Review of Nutrition Research,* Vol. IX, No. 8, October 1948.

Tracerlog. House organ of Tracerlab, Inc., 55 Oliver Street, Boston 10, Massachusetts.

Air conditioning design, by H. C. Hoffmann and G. B. Priester. Application data booklet (AD 44) published by the American Society of Refrigerating Engineers, 40 West 40th Street, New York City. Copies available at $.40 each.

Report of the president of the Johns Hopkins University, 1947–48.

Bovine plasma proteins. An annotated bibliography prepared expressly for scientists and medical specialists by the staff of the Chemical Research and Development Department of Armour and Company, Chicago 9, Illinois. Available upon request to above address.